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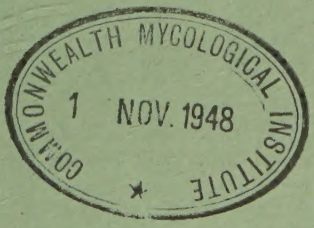

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N.A.A.S.

QUARTERLY REVIEW

THE JOURNAL OF THE N.A.A.S.

1948 No. 1

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A FOREWORD

BY THE MINISTER

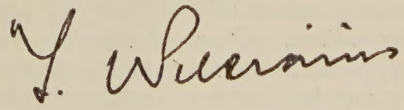
There is cause for the gravest anxiety about the future food supplies of our country : prospective world production is far short of minimum needs, and, in the circumstances in which we are now placed, we must expect continuing difficulty in maintaining our imports. A heavy responsibility thus rests on all of us who are concerned, in one way or another, to secure increased production from our own acres.

One means to this end is to secure the quickest and widest possible application, in the field and in the cowshed, of every useful scientific discovery or invention, and of every new idea in farm management or practice.

The pace of progress is now so fast that it has become very hard for the Adviser, with the multitude of duties that fall to his lot, to keep his knowledge up-to-date. The purpose of this Quarterly is to help him to do so.

We are living in difficult times. I have learnt of many of the particular difficulties and discouragements with which the new Advisory Service has had to contend. But I am convinced that much has already been accomplished, and I am confident that the Service is on the way to achieve all that we originally hoped.

Much depends upon your efforts, and I wish you all success.



AN INTRODUCTORY NOTE

BY THE DIRECTOR-GENERAL

It is with much pleasure that I write this introductory note for the first number of the N.A.A.S. Quarterly Review.

The main purpose of the Review is explained in a few words. It is very necessary that the members of the National Agricultural Advisory Service and associated workers in the field should be kept fully informed of the progress and results of the more important research and experimental work which now constitutes the wide field of agricultural science. On the other hand it is, of course, quite impossible to find the time to read all the original papers and reports and the various journals, etc., which are regularly issued.

By acting as a channel of information it is hoped that this Quarterly Review will contribute to the task of keeping the service generally informed. Needless to say it is not intended that it shall in any way compete with existing organs of information normally available to specialist officers working in the field of applied science.

In the main, the Quarterly Review will consist of a series of abstracts covering the main branches of agriculture, horticulture, poultry-keeping, and related sciences, together with a limited number of short articles on important matters of current interest. The Quarterly Review will also serve as a medium of information on provincial activities. Our chief aim, therefore, is to serve the " general practitioner " of the service by assisting in keeping him informed.

Naturally, a publication of this type could not carry out its mission successfully without full support from the various fields of agricultural science. I therefore particularly desire to express my appreciation of the generous co-operation we have been promised by a large number of specialist contributors.

JAS. A. S. WATSON.

ARTICLES

IMMUNITY AND IMMUNISING AGENTS

PROFESSOR T. DALLING

Livestock, like all living things, suffer from diseases which are caused by living agents : they include micro-organisms of many kinds, viruses and agents, usually referred to as parasites, varying from the members of the small protozoan group to the larger varieties of worms. Many animals are exposed to such agents all the time, or for longer or shorter periods, and unless there was some provision for their protection against the effects of infections or infestations livestock would soon cease to exist. Protection does exist, however, and to it is applied the term " immunity." Immunity is a complex subject, and ideas and facts concerning it are constantly being conceived and ascertained. The object of this article is to place before the reader in a simple form some of the general knowledge on immunity and the methods adopted for its creation. Some of the common diseases of livestock and the methods adopted in immunisation against them will be used by way of illustration.

Immunity may be defined as the power of the animal body to resist infection by parasitic micro-organisms, viruses and other agents as well as the injurious effects of their products or toxins. We recognize two main branches of immunity (*a*) natural, and (*b*) acquired. One species of animals has a natural immunity to some of the diseases which affect another species, e.g., cattle do not develop swine fever nor do human beings become affected with fowl pest. This resistance is referred to as natural immunity, which is inherent in the species : when a disease is confined to one species it is said to be specific to that species.

In parasitic worm infestation specificity of host may also be well marked, for, because of the failure of certain types of intestinal worms found in sheep to infest cattle and horses, these animals can be grazed together on the same pastures : in this instance such joint grazing may be beneficial in that one species of animal, by picking up the larval forms, destroy the worms and so help to reduce the infestation of the pasture and make it safer for the other species.

Acquired immunity, as its name implies, is developed by the animal and is not present as a natural condition. This type of immunity may arise from exposure of the animal to an infection, following which protective substances are produced in the animal's body and remain there in a greater or lesser degree for long or short periods, and protect the animal against a similar infection when exposure takes place in the future. Much acquired immunity follows an attack of an infectious disease : thus if a human being is infected with small-pox and recovers, an acquired immunity is produced which persists for a very long period, or if a dog recovers from an attack of true distemper it is rendered immune, usually for the rest of its life. Acquired immunity may, however, cause some trouble, not in the immune animal itself but to other animals coming into contact with it, for, because of its immune state the animal may harbour and disseminate micro-organisms or other parasites which, in their turn, may infect susceptible, non-immune animals. This does

not occur very often. Immunity may also be acquired as an animal becomes older : age resistance is recognized in some diseases in which it is possible to set up an infection only with much difficulty (or it may be impossible) in an older animal, whereas young stock are highly susceptible. Some of the sheep diseases associated with the anaerobic group of micro-organisms fall into this category. It may be that in some instances, at least, the immunity is acquired by exposure to the infection during young life. In acquired immunity due to exposure to infection it is to be remembered that the infecting agent does not necessarily set up clinical symptoms of disease before the immunity can develop. Mere exposure to the agent may be sufficient to stimulate the production of immunity without any recognizable symptoms of disease occurring.

Acquired resistance or immunity can sometimes be set up by artificial means and such measures are made use of largely in the control of animal health. When a rapid immunity is needed to prevent disease, e.g., in animals recently exposed to infection or about to be exposed, the method differs materially from that used when an immunity of long duration is desired. For the former type protective substances produced in a different animal are used in the form of an antiserum or antitoxin, while in the other type, substances called antigens, produced from the infecting agent, are used on the animal concerned, which then prepares its own protective substances. These two forms of immunity are referred to as passive and active immunity respectively. Passive immunity is set up by the injection of already formed protective substances, and is of short duration because the substances, being foreign to the particular animal, are quickly thrown out of the body. Active immunity follows the stimulation of the protective mechanism of the body by the use of an antigen and is of long duration but gradually decreasing in intensity because, being prepared by the animal itself, it is a natural part of the animal's make-up and is thrown out very gradually. Another point of importance in active immunity is that once the protective mechanism of the body has been stimulated to produce protective substances it can very quickly and easily be again brought into action. For this reason, in order to increase an active immunity against a specific infecting agent repeated injections of antigen are often given at recognized intervals.

Acquired immunity, be it passive or active, depends upon the presence of substances called antibodies, of which several types are recognized, e.g., agglutinins, antitoxins, antibacterial bodies, etc. These antibodies are largely specific and by the amount present, which can be measured, indicate the state of the animal's immunity. They are found in different parts of the body but are readily recognisable in the blood. Each of the different antibodies appears to have separate functions : they are not present in similar amounts and in some cases some of them may be absent or in such a small quantity that they cannot be recognized. The recognition of some of these antibodies is also made use of in the diagnosing of the presence of infection or indicates that the animal has been exposed to the infection. Thus, in brucellosis (contagious abortion) the presence of agglutinins (as shown by the agglutination test) shows, in an unvaccinated animal, that infection with *Br. abortus* is present or that the animal has suffered from such an infection. The titre, i.e., the

dilution of the blood serum at which agglutination takes place, assists in arriving at a conclusion on the presence of the infection or whether the infection has passed : in addition, the results of repeated agglutination tests are helpful in this respect. Antibacterial bodies and antitoxins are usually demonstrated by the protective value of the animal's blood serum when mixed with the causal organism or toxin and injected into laboratory animals.

Many micro-organisms produce harmful substances, called toxins, which cause disease in animals. If such organisms are washed free from their toxins they may do little or no harm when injected into animals. Good examples of micro-organisms which produce potent toxins in animals are those of the *Cl. welchii* group which cause lamb dysentery, pulpy kidney disease, strike, etc., in sheep. The micro-organisms are found in the intestine and under suitable conditions multiply there and produce toxins which are absorbed from the intestine into the general body tissues. The injection of such toxins into a susceptible animal may cause death or may produce an illness from which the animal recovers : much depends upon the potency of the toxin and the amount injected. If the animal survives the injection, antitoxin is produced in its body and a state of active immunity exists. In protecting animals against disease caused by toxins, a passive or an active immunity is set up by artificial means. For a passive immunity the antitoxin is used : it is usually prepared in horses by the process of hyperimmunization. Gradually increasing doses of the toxin are injected into the horse at intervals until the animal's serum contains large amounts of the antitoxin : the injections may be spread over weeks or months. The horse is then bled and the serum is recovered. The serum is referred to as the antitoxin, and when injected into the susceptible animal, e.g., a young lamb for the prevention of lamb dysentry or pulpy kidney disease, gives rise to a passive immunity of short duration. For the creation of a passive immunity against a disease caused by a micro-organism in which toxin does not play a part, or by a virus, antibacterial or antivirus serum is used. Here the bacterial body or the virus is injected into a horse or other animal : with this exception the method largely resembles that used in the preparation of an antitoxin. An example of an antibacterial serum is anti-swine erysipelas serum.

Active immunity is produced by the susceptible animal itself, and follows stimulation of the body's protective mechanism by the injection of an antigen. An antigen can be defined, broadly speaking, as any substance which will stimulate the development of this mechanism : such substances are said to have antigenic properties. They are commonly referred to as vaccines. Vaccines are prepared in many different ways and only experience will show the most satisfactory method to adopt. In diseases caused by toxins, the toxin itself may be the vaccine : this, however, is seldom used, largely because of the difficulty in grading the potency and dose so that no harmful results occur in the injected animal. Toxoids or anatoxins are used : they are the products resulting from the treatment of the toxins, usually with chemical substances, e.g., formalin, and while the treatment renders them harmless when injected, they still retain their antigenic characters and can stimulate the production of an

active immunity. Sometimes the micro-organisms *and* their toxins are used as antigens : they also are treated chemically and are then known as anacultures. When an active immunity is desired in livestock against a toxin-producing micro-organism, the vaccine is often an anaculture, e.g., as used for the control of braxy in sheep.

Active immunity against a disease caused by a micro-organism which does not produce toxin is obtained by the injection of vaccine containing the micro-organisms themselves : they stimulate the production of antibacterial bodies. These vaccines vary from disease to disease and may consist of the bodies of the micro-organisms killed by heat or by chemical means, or it may be necessary to inject them in the living state. It is seldom that a vaccine contains living, *virulent* micro-organisms. When living organisms are necessary to stimulate the production of active immunity, special strains, called attenuated strains, are generally employed. Good examples are the strains of micro-organisms used in anti-anthrax vaccine, anti-abortion vaccine, and B.C.G. tuberculosis vaccine. The strains may be naturally feebly virulent or attenuated, or may be rendered so by methods of artificial cultivation or other means.

Active immunity against virus infections can also be set up by the use of the disease-producing virus. Fowl pox vaccines used in some countries contain the actual virus of fowl pox, but in this country we use the closely related virus of pigeon-pox in its live state : the immunity from the latter, however, is of shorter duration than that engendered by the virus of fowl-pox. Active immunity against fowl pox can also be produced by the use of virus grown in the developing chick in eggs. In louping-ill in sheep the virus contained in the brain of artificially infected sheep is used : the brain substance, rich in virus, is treated chemically and constitutes the vaccine. Swine fever virus is contained in the blood of infected pigs. The addition of the dye, crystal violet, to blood containing large amounts of virus results in a highly antigenic vaccine, which, when injected, renders susceptible pigs actively immune for at least twelve months.

A good example of the development of active immunity followed by passive immunity is the immunization of lambs against lamb dysentry. Anaculture is injected into the ewes and an active immunity results : the antibodies are passed to the colostrum as it forms in the udder and they reach the lamb when it sucks soon after birth. Absorption from the intestine goes on until the lamb is about four days old and thus the lamb is rendered passively immune during its susceptible period of life. It is of interest to note, in passing, the importance of the protective antibodies in the colostrum of all animals, and the part they play in protecting young animals against infections during their early life.

In discussing antibodies in general the part played by agglutinins is worth mention. Their action seems to be to cause clumping of the invading micro-organisms, thus rendering them immobile, in which state they can readily be removed by certain blood and tissue cells. It has to be pointed out, however, that the absence of agglutinins in the blood-serum of an animal does not necessarily mean that a state of immunity does not exist. Thus certain strains of *Br. abortus* stimulate the production of only small amounts of agglutinins and soon their presence cannot be

recognized. With the present anti-abortion vaccine (Strain 19) although agglutinins develop in large amounts, they cannot be recognized after a time, especially if the vaccination is carried out in calves : and still the vaccinated animal is highly immune to *Br. abortus* infection.

There exist other antibodies which have not been described, but this description of immunity and immunization methods may give a general impression of the subject and provide information about the means adopted to control infectious diseases of livestock.

THE BREEDING OF DISEASE-RESISTANT VARIETIES

E. T. Jones

Welsh Plant Breeding Station

In Britain the incidence of disease in cultivated crops is highly seasonal, and only rarely does a particular disease develop into an epidemic. An exception is the field bean which, because of its susceptibility to chocolate spot disease and aphis attack, gives, in many districts, very erratic and unsatisfactory yields. In general, however, even in seasons favourable to disease, our cereal and other crops escape with moderate damage, and only here and there suffer severe injury. Probably, it is for these reasons that we in Britain have placed less emphasis on the breeding of resistant varieties than those countries where losses from disease are often catastrophic.

In the United States and Canada, for example, where grain and other crops are grown in large contiguous tracts of land, cultural as well as climatic conditions favour severe outbreaks and rapid spread of disease. In these circumstances it is not surprising to find intense activity in the breeding of resistant varieties. The beneficial results obtained thereby are often striking ; indeed, continued success in the cultivation of grain crops in these areas depends, more than anything else, on the ability of the sown variety to resist attack by fungal and other pests.

For instance, the barley acreage grown in the State of Iowa has fallen in the past fifty years from 250,000 to 12,000 acres, largely because of failures due to disease coupled with the increased reliability of oats that has followed the introduction of new disease-resistant varieties. As a first step towards the mitigation of these losses no less than 4,328 barley varieties from world-wide sources have been assembled at Ames, Iowa, and a search is being made for plants possessing genes for disease resistance. The ultimate aim is to produce, by crossing and recombination, the smallest possible number of varieties with the maximum resistance to the largest possible number of diseases, that will meet the needs of the different geographical regions.

At most of the agricultural experiment stations in North America resistance to disease now ranks as first priority in the crop-improvement programmes. The effectiveness of the work is illustrated by the following outline history of oat breeding.

Crop-improvement work at Ames, Iowa, started in 1906, and the first success was obtained with pure lines selected from Kherson and Sixty-Day oats, the first of which was distributed to growers in 1913.

These gave an average increase, in Iowa, of approximately ten bushels per acre, or about 30 per cent., over the types formerly grown. The gain was due partly to the improved rust resistance and partly to the earlier ripening habit of the new selections, which enabled them to mature before the date when crown rust ordinarily becomes severe.

Next the **Victoria** variety, now known to be resistant to 76 of the 82 known physiologic races of crown rust, was introduced from South America and was crossed with the stem rust-resistant lines. From these crosses were produced the new varieties **Vicland, Tama** and others, which gave a further improvement of 20 per cent. in grain yields.

In quite recent years, the variety **Bond** (immune from 75 physiologic races of crown rust) was obtained from the plant breeding section of the Department of Agriculture, Sydney, and crosses from it gave a third group of new varieties, including **Clinton, Benton** and others. These possess resistance to most of the commonly-occurring races of crown rust (except Race 45), to stem rust and smut, and also to *Helminthosporium victoriae*. The last is a new disease closely related to *H. avenae* and is only partly controllable by seed disinfection. Seed of these new varieties will be available in 1948 in quantities sufficient to meet the whole of the requirements of Iowa, as well as those of some of the neighbouring States. Their superiority in grain yield is said to represent a further advance of about 10 per cent. Thus, within a period of less than forty years of intensive breeding, a total average increase in grain yields of 25 bushels per acre (30 lb. per bushel) has been achieved, and the major part of this is attributable to the development of disease-resistant sorts.

At the research stations of the United States Central Experimental Station at Beltsville near Washington, several workers are fully engaged in fundamental researches in crop pest problems. There is close collaboration between the Federal and State workers, and between the entomologists, pathologists, bio-chemists and plant breeders. Adequate facilities in the form of suitably equipped greenhouses, laboratories and land are available. In the country as a whole a vast staff is fully occupied with practical crop improvement work in all its various phases. Work on similar lines is in progress at the Dominion Rust Research Laboratories at Winnipeg, as well as at other research stations in Canada. New techniques are being evolved for the study of plant diseases, including the production of artificial epidemics in isolated field nurseries.

Apart from oats, important advances have been made in pest resistance in other crops. In wheat, for example, the varieties **Pawnee** and **Kawvale,** which are resistant to Hessian fly, have been produced by United States workers, and in Canada the new variety **Rescue,** with solid stems, is highly resistant to stem sawfly. Lucerne varieties resistant to bacterial wilt are also undergoing experimental tests. The problems involved in breeding for resistance to crop pests are by no means fully solved, but the progress already made in America is very important.

Plant breeders in Britain are, indeed, fully conscious of the loss of yield and quality in diseased crops, and effective steps have been taken, in many cases, to meet the situation. One well known case is the development of potato varieties immune from wart disease. Other work with

this crop, begun by Salaman and now pursued by Black at Edinburgh and Howard at Cambridge, aims at producing blight-resistant, and virus-immune or virus-resistant varieties. Again, Biffen, in the early years of the present century, demonstrated that resistance to attack by wheat rust was an inherited character and behaved similarly, in inheritance, to such morphological characters as grain colour, size and shape of the ear. Realizing the significance of this fact, he went on to produce the varieties **Little Joss** and **Yeoman,** which together with **Holdfast** and **Steadfast** (later evolved by Engledow) possess high resistance to yellow rust.

Some of the difficulties have been the lack of suitable equipment for artificial inoculation in the greenhouse, and for the creation of artificial disease epidemics in the field ; in these circumstances progress in the breeding of disease-resistant varieties is dependent upon the frequency of natural epidemics in the field, and is therefore slowed down. It is known, as a result of the discovery of the existence of physiological races within the different species of rusts and other fungi, that crop varieties may show resistance to disease in one area, but susceptibility in another. At times, indeed, there may be a breakdown of resistance, but generally the different behaviour is explained by differences in the local prevalence of different physiological races. A particular variety may be resistant to some races of rust and highly susceptible to others.

More than two hundred physiological races of wheat stem rust are known to occur throughout the world. Moreover, new races may arise from time to time. It may not be possible, and fortunately it is not necessary, for the plant breeder to develop suitably adapted varieties resistant to all the physiological races of some particular disease. Usually, it is enough if he considers those races which predominate in the particular area in which a given variety is to be grown. But the possibility must be faced that one of the rarer races may take the place of the one that formerly prevailed. The behaviour of new varieties must, therefore, be closely watched, and any observed tendency for rare races to expand, or for new ones to appear, must be met by crossbreeding to incorporate resistance to the aggresive forms.

The breeding of highly resistant varieties by hybridization is, for these reasons and others mentioned below, a slow process and must be a continuing one. The general means of speeding up the work is the provision of greenhouses, equipped with artificial light and temperature controls, in order to allow two or more complete generations to be grown each season. There are other difficulties : when varieties and species are inter-crossed the plant type is broken up, and undesirable economic characters may be introduced by one or other parent. Linkage between the genes for these undesirable characters and those for disease-resistance may also occur. Initial progress is of course dependent on the existence and discovery of resistance genes in plants either of the same species or of some related species which is cross-compatible with the crop plant to be improved.

In a study by the writer and Walters Davies of the inheritance of resistance to crown rust in oats, crosses were made at Aberystwyth in 1923 between the varieties **Red Rustproof** (*A. sterilis culta*) and **Scotch**

Potato (*A. sativa*) which is a highly susceptible variety. Segregate selections from this cross showed resistance to the races studied under greenhouse inoculations, but most of them later proved to be susceptible to races occurring in the field. Advanced selections from further crosses made in 1938 of **Victoria-Richland** and **Bond-Green Russian** (two introduced American varieties which carry a large number of genes for resistance) with **S.84, Thousand Dollar** and **Marvellous** are now under study, and their reactions to local races of rusts are being observed. The occurrence of a widespread natural infection of rust in the field nurseries in the 1945 and 1947 seasons greatly assisted in the isolation of a number of resistant plants. Attempts in 1925 and 1926 to create an artificial epidemic in the field nursery were only partially successful, but with the newer technique evolved in America and Canada this possibility is being investigated afresh.

Advances are also being made in the development at Aberystwyth of oat varieties resistant to mildew (*Erysiphe graminis L.*). Two new selections have now reached the yield-test stage and, while not immune from mildew, they have been shown to possess a high degree of resistance.

In the species of both oats and wheat grown in Britain, there is a general lack of disease-resistance genes. It is therefore necessary at the start to explore foreign material in search of the required genes. Several inter-varietal or inter-species crosses may have to be made before genes giving resistance to the more destructive diseases can be incorporated in a single variety. Furthermore, any new variety so produced should possess, in addition to disease resistance, the high merits of existing varieties in respect of yield, quality and other important agronomic characters ; otherwise there will always be a tendency for growers, following seasons in which disease is less abundant, to revert to the other non-resistant varieties.

In respect of insect and other crop pests, evidence of differential resistance in oats to attack by Frit fly has been obtained by Cunliffe and Hodges at Oxford ; and varietal resistance in winter oats to injury by stem eelworm has been proved by Goodey at the Institute of Agricultural Parasitology.

The most important disease and pest of herbage legumes in Britain are clover rot and clover eelworm, which attack all strains of early-flowering broad red clover. Practically every breeding station in areas where this crop is important is engaged in the search for resistant types. A certain degree of resistance has been observed by Watkin Williams in some of the late-flowering red clovers, but it does not approach complete immunity. No powers of resistance have so far been discovered in any plants of the early broad red clover group.

In grass breeding positive selection for resistance to the predominant diseases is practised by Jenkin and Beddows at the Welsh Plant Breeding Station at the initial stage, i.e., in selecting mother plants for strain building. Any individuals showing susceptibility are discarded, and so also are healthy plants which, under breeding tests, show a tendency to segregate susceptible offspring. Unlike the self-pollinated cereals (where all the plants of a given variety are in general of like genetic constitution, and therefore of similar reaction to attack by disease) the

individual plants of cross-pollinated species differ genetically in greater or lesser degree. Each "mother" plant, and also its progeny must, therefore, receive individual attention.

Rusts on some strains of timothy can be destructive to the point of causing the complete annihilation of the plants. In other species the foliage may in some seasons be partially destroyed, but the plants quickly recover.

Fortunately, genes for resistance to many of the prevailing diseases are to be found, although quite often only amongst the wild populations and the ancestral stocks of the cultivated species. Advances in this specialized form of breeding, therefore, will depend largely upon the collection of material from various and often widely diverse habitats. Explorations of this nature have already been made in connection with potatoes, resulting in the collection of plants of *Solanum demissum* (the Mexican wild potato) which carry genes conferring resistance to various forms of blight. In these searches plant breeders can make use of the services of the Commonwealth Agricultural Bureaux which assist in the interchange of material between breeders in different parts of the Commonwealth and elsewhere. The Bureaux organization also keeps records of plant material of possible value for breeding purposes, and maintains a collection of South American potato species and varieties. At present active steps are being taken under the Food and Agriculture Organization of the United Nations to set up an international scheme for promoting co-operation between plant breeders. These organizations will also be concerned with encouraging and co-ordinating plant exploration, and with safeguarding the maintenance of important stocks of such native and wild species as may be valuable to plant breeders in their efforts to increase world food supplies.

PLANT VIRUS DISEASES

Kenneth M. Smith

Before considering some of the more important virus diseases of crop plants, it may be of interest to describe very briefly the present state of our knowledge of the viruses themselves. With the isolation by Stanley of the tobacco mosaic virus in 1935, it became possible to regard a virus as a tangible entity, and no longer as a mysterious something the existence of which could be recognized only by the disease it caused. In the last decade the study of viruses, apart from virus diseases, has developed greatly, and several plant viruses have been isolated in crystalline form. Among them, besides the tobacco mosaic virus group, are the viruses of tomato bushy stunt, tobacco necrosis, southern bean mosaic and turnip yellow mosaic. These have all been identified as nucleo-proteins.

With the advent of the electron microscope (see Fig. 1 of inset between pp. 26-27) the size and shape of several viruses have now become known. The first virus to be photographed by means of this instrument was that of tobacco mosaic, and the results confirmed what had already been suggested by other methods, i.e., that the particles of this virus were long, thin rods (Fig. 2). On the other hand the virus particles of tomato

bushy stunt, tobacco necrosis, southern bean mosaic and turnip yellow mosaic are all spherical (Fig. 3), and since in the individual viruses they are all of the same size and have identical chemical and physical properties, it may be inferred that these particles are actual virus molecules. Their size, which differs slightly with different viruses, varies between 20 and 30 millimicrons (one millimicron equals a millionth of a millimetre).

Photographs taken recently on the electron microscope of single virus crystals, at a magnification of about 80,000, have revealed for the first time in history the actual arrangement of the molecules in the crystal lattice.

The virus of turnip yellow mosaic, which is the latest virus to be crystallized, and which is mentioned in this article, shows some interesting properties (Fig. 4). It occurs in two forms, which seem identical in every way but one, and which give rise to identical crystals. The way in which they differ is that one form has no nucleic acid and apparently is not infectious. It seems, therefore, that nucleic acid is essential for the multiplication of a virus.

Of the large number of viruses affecting plants in the United Kingdom about eighteen are of serious economic importance, and it is to these that attention is confined in this short article. Some of the confusion which attended the early studies of viruses affecting the potato plant still persists, and a short statement on these may help to clarify the situation. It should be remembered in the first place that different potato varieties may respond differently to the same virus ; thus, whilst most varieties respond to infection by potato virus X with a mottle, others, such as *King Edward*, develop a top-necrosis. As to the actual viruses themselves, they consist firstly of the single leaf-roll virus, and secondly of the two virus groups, the X and Y-type viruses.

The virus causing the leaf-roll disease is not transmissible by mechanical means but is entirely dependent upon aphides (mostly the small peach and potato aphides *Myzus persicae*) to spread it around. The primary symptoms of the disease consist first of a slight pallor on the youngest leaves followed by an inward rolling of the leaf edges ; as the infection spreads the rolling develops on the outer leaves as well, and the whole plant becomes stunted and unproductive.

Now as regards the mosaic-type viruses, the X and Y groups, virus X is sap-transmissible but, so far as is known, has no insect vector. It spreads by contact between the haulms and also by root contact ; it cannot be transmitted by the knife used for cutting the seed pieces unless the cut passes through a well grown shoot. Virus X is the most ubiquitous of all viruses, and is present wherever the potato is grown. It is extremely insidious because it occurs in a large number of strains of varying virulence and the milder strains may produce little or no symptoms on the plant. Nevertheless it is important to realize that these mild or symptomless strains reduce the yield by as much as 10 per cent.

The rigorous roguing carried out by the Scotch seed potato inspectors has resulted in the artificial selection of a mild strain of potato virus X which is now present in much of the Stock Seed Certificate potatoes, and some varieties, Kerr's Pink for example, seem completely permeated with the virus. Since these mild strains of virus X cannot be eliminated

by roguing, they have to be detected by other means such as inoculation to indicator plants and by serological tests ; these methods have been described in detail in *Farming* for February, 1948.

Potato virus Y, which causes *severe mosaic* or *leaf-drop streak*, is also mechanically transmissible and, unlike virus X, it apparently does not spread by contact, but is transmitted by aphides, mostly *Myzus persicae*, and to a lesser extent by one or two of the other potato aphids. The first sign of infection, in most potato varieties, is the development of dark necrotic streaks on the veins of the undersides of the younger leaves. These necroses spread and coalesce until the whole leaf becomes necrotic and hangs down but remains attached to the stem. The top of the plant remains green but is usually mottled ; in the following year the diseased plant is dwarfed and the leaves show a rusty necrosis, a condition frequently known as curly dwarf. Potato virus Y also occurs in strains of varying severity and these have recently been described by Bawden and Kassanis (*Ann. appl. Biol.*, **34** (1947), 503).

The next viruses of agricultural importance are those attacking sugar-beet and are two in number ; they cause *sugar beet mosaic* and *sugar beet yellows* respectively, the last named being the more important of the two. The mosaic virus is mechanically transmissible but the yellow virus is not ; both are transmitted by the peach aphis, *Myzus persicae*, and the black bean aphis, *Aphis fabae*.

The symptoms of the two diseases are as follows : in sugar-beet mosaic the first signs of infection develop in the youngest leaves, which usually show a " clearing of the veins," and this is followed by a mosaic mottling of light- and dark-green which is confined mostly to the central part of the plant. In sugar beet yellows there is no mottling or preliminary clearing of the veins and the symptoms are confined mostly to the outermost leaves. As the name implies, the affected leaves show a pronounced yellowing together with a brittleness and thickness of the blades. Thus a mature beet plant infected with yellows shows no symptoms on the youngest leaves, but the outer leaves exhibit a characteristic yellowing with a wavy appearance. Such leaves are extremely brittle ; they rattle and tend to splinter when crushed.

The main sources of infection are the sugar beet and mangold seed crops which are usually heavily infected with both yellows and mosaic viruses ; these crops enable the viruses to overwinter. Other sources of infection are mangold clamps, groundkeeper beets and the biennial varieties of beet such as winter spinach and seakale beet which are often grown in gardens. As regards seed-transmission, the evidence is mainly against this, but a letter has appeared recently in *Nature* stating that the yellows virus is seed-transmitted in one particular strain of beet only. Further work, however, is required on this matter before it can be regarded as settled.

In recent years attention has been drawn to the increasing degeneration of cruciferous crops, more especially broccoli. Whilst the whole of this decline is probably not attributable to virus infection, there is no doubt that much of it is due to this cause. Three viruses are known to infect cruciferous crops in this country, and frequently two of them are associated with broccoli. These are two rather similar, aphis-transmitted

viruses, which will be dealt with first, and the third virus, which is of a different nature, and will be described separately. The aphis-transmitted viruses (*Brassica Viruses* 1 and 3 in the writer's book, *A Textbook of Plant Virus Diseases*) cause the diseases known as *cabbage black ring-spot* and *cauliflower mosaic* respectively. In the first of these the primary symptoms consist of small chlorotic spots which give a mottled appearance to the leaves ; a little later these spots develop necrotic edges and finally turn into the black rings and spots which give the disease its name. As the disease develops the necrosis increases and the veins and midribs become blackened, the whole symptom picture resembling rather a bacterial disease. In cauliflower mosaic, the first sign is a clearing of the veins of the youngest leaves, a point of difference from cabbage black ringspot. The vein clearing may persist for a few days, and is then replaced by a characteristic " vein-banding," which consists of narrow, dark-green areas parallel with and adjoining the midrib and lateral veins ; this symptom is most pronounced about 5-6 weeks after infection. These two viruses occur commonly in broccoli and may often be found together in the same plant ; both are transmitted by the aphis, *Myzus persicae*, and by the mealy cabbage aphis, *Brevicoryne brassicae*.

The third virus affecting cruciferous crops, only recently described, is known as *turnip yellow mosaic* from the bright yellow mottling which is the most characteristic symptom. This virus differs in many ways from the two aphis-transmitted viruses just described, particularly in its method of distribution ; the insect vector is neither an aphis nor any kind of sap-sucking species, but one with biting mouthparts. In the field the virus is spread by the common turnip flea beetles, *Phyllotreta* spp., and is often found attacking turnips. The turnip plants first show a pronounced clearing of the veins, followed by an unusually bright-yellow mottling of the leaves ; later, growth ceases and the plants remain small, stunted and chlorotic. The virus has been recorded as affecting turnips, kale and broccoli, and it appears to be common in the south-west of England and in the Edinburgh district of Scotland.

As regards horticultural crops, the tomato is perhaps most commonly affected with viruses, and of the tomato virus diseases five will briefly be described. *Tomato mosaic*, caused by the same virus that causes tobacco mosaic, is present in most commercial glasshouses, and although the disease is not severe, the annual loss caused by this almost universal virus must be considerable. There is insufficient space to discuss the controversial question of whether or not the virus is transmitted through tomato seed, it suffices to say that if seed-transmission does occur it must be very rare. It should be emphasized, however, that the virus is extremely resistant, and infection may quite well overwinter on contaminated instruments or in pieces of plant tissue. The danger of infecting young tomato plants with virus from smoking tobacco should also be borne in mind. Tomato stripe, or glasshouse streak, which is due to a strain of tobacco mosaic virus, is a much more severe disease. The main symptoms are necrotic markings, and large areas of the leaves may die ; in addition there is frequently a necrotic streak or stripe running up the main stem from which the disease derives its name. Tomato

stripe exists apparently in two forms, the severe type just described and the mottling disease which resembles ordinary tomato mosaic. The exact significance of this is not completely understood, but probably it is partly a varietal reaction. These two tomato diseases are spread only by mechanical contamination.

Tomato spotted wilt is becoming a serious threat to the tomato grower, particularly the grower with mixed houses, and this point will be discussed in a later paragraph. The first sign of spotted wilt on the tomato plant is the development of a metallic bronzing of the younger leaves ; this bronzing rapidly dries out and the leaves are killed. The disease is frequently fatal to young tomato plants. The virus of tomato spotted wilt is transmitted by a thrips, *Thripst abaci*, and is probably the only virus which has this type of insect as a vector ; no other kind of insect is able to spread it. Like most of the viruses that affect the tomato plant, the spotted wilt virus has a very wide host range, and this is true also of the virus of cucumber mosaic. The latter virus attacks the tomato plant only occasionally because it is an aphis-borne virus, and the tomato plant is not favoured by aphides ; the symptoms are of the fernleaf type.

The last tomato virus to be discussed has only recently been described and the disease it causes is known as *tomato black ring*. The symptoms on the young tomato plant are very severe, and somewhat resemble those of spotted wilt except that there is no metallic bronzing and the necroses on the leaves are in the form of small black necrotic rings. If the young plants are not killed, they grow away from the severe type of symptom, exhibiting numbers of rather faint single or concentric rings on the leaves. Tomato black ring virus is peculiar in that it is able to infect a very wide range of plants, many of which carry the virus without showing symptoms. No insect vector has been discovered, and the method of spreading is not known. It is unlikely to spread by mechanical contact because of its low concentration in the host plant.

Two viruses, those of spotted wilt and cucumber mosaic, already mentioned as affecting tomato plants, are also concerned in the virus diseases of ornamental plants such as arum lily, zinnia, gloxinia, chrysanthemum and dahlia. The tendency is for the spotted wilt virus to form rings on the leaves of most of these plants, at all events in the early stages of infection ; later a mosaic mottling may develop. The exception is the chrysanthemum, on which symptoms are vague and indefinite. As mentioned when describing the virus diseases of the tomato, it is in the glasshouses carrying mixed crops that this virus is most important because the ornamental plants afford an easy means of overwintering and constitute a perennial source of infection for the tomato crop. Cucumber mosaic virus is also found in a similar range of ornamental plants, including gladioli and viola. This virus frequently causes a " break " in the colour of the flowers, particularly in the two last named.

There are two other crops which, from the virus point of view, have lately been brought to the fore ; these are lettuce and watercress. Lettuce is susceptible to infection by four viruses, those of lettuce mosaic, cucumber mosaic, dandelion yellow mosaic and tomato spotted wilt. The first three are all aphis-transmitted, and in addition the virus of

lettuce mosaic is seed-transmitted. The symptoms of lettuce mosaic vary to some extent according to the variety of lettuce. In some varieties, such as Tom Thumb, the symptoms are a mosaic mottling but in others, Cheshunt Early Giant for example, there may be extensive necrosis of the growing point. A mature cabbage lettuce in the field, when affected by this virus, shows dwarfing, defective hearting, mottling and necrosis or scorching. As regards the virus of cucumber mosaic, this is said to give rise to brown markings on the outer leaves and brown ringspots on the heart leaves. More information is required as to the amount of infection in lettuce by this virus. Occasional outbreaks of dandelion yellow mosaic virus in lettuce have been recorded, but infection by tomato spotted wilt virus in this country is not common.

Just recently watercress growers have become aware of the fact that the crop is rapidly deteriorating, and studies by Cheo at Cambridge have shown that the decline is due to widespread infection with one or more strains of the cabbage black ringspot virus. Tests made at random of watercress samples in East Anglia showed that infection with this virus was as high as 50 per cent., the green cress, *Nasturtium officinale*, being the worst affected. Watercress plants infected with the cabbage black ringspot virus are stunted and have small mottled leaves ; they make very slow growth. Although the aphids, *Myzus persicae*, and *Brevicoryne brassicae*, are both able to transmit the virus, it is not clear whether either of these or some other species is the vector in nature. It seems probable that continuous vegetative propagation from infected stocks is the chief method of spreading the disease.

ABSTRACTS

ANIMAL BREEDING

Sire Survey and Merit Register—New Zealand Dairy Board, 1945

This publication includes all the available official Sire Surveys for New Zealand, and gives valuable information on the testing of bulls. Some of the more important points brought out are :

(1) The highest producing cow in the herd does not always leave a high producing daughter—in fact an extensive analysis of surveys shows that in 40 per cent. of cases the daughter of the top cow was lower in production than the average for all daughters, whereas in the same proportion of cases, the daughters of the lowest producing dam in the survey were better than the average of all daughters. In other words, as regards breeding qualities, the best cow is not by any means as good as her own record suggests, and the worst cow by no means as poor as her production indicates.

(2) Progeny testing, because it measures the qualities actually being passed on by the parents, is more effective than a system of testing the producing qualities of the parent.

(3) The results of the Sire Survey show that only 4 per cent. of the bulls tested, are capable of improving the butter fat production of the daughter over the dam, where the latter has a yearly production of 400 lb., or over, whilst 80 per cent. of bulls will lower the production. At the other end of the scale, 66 per cent. of bulls will improve production of daughter over dam where the butter fat of the dam is 300 lb. or below. Only 13 per cent. of bulls will lower this standard. This shows the stalemate which confronts the herd testing movement in improving standards of production, unless some general improvement takes place in the standard of bulls used.

The emphasis of dairy herd improvement, so far as breeding is concerned, is therefore placed on progeny testing with the bull and on lifetime records with the cow. In the first case, information is made available on the actual qualities being transmitted to the progeny by the bull, and in the second the lifetime record of the dam indicates the degree to which she has combined the four qualities necessary for a sound dairy cow, namely :

Sound butter fat production qualities ;
Fertility—ability to calve regularly ;
Resistance to disease—sound constitution ;
Length of working life.

The Growth of the Lamb before and after Birth in Relation to the Level of Nutrition. Wallace, L. R. *J. agric. Sci.*, **38** (1948), 2.

Experiments were carried out with ewes to show how the level of feeding during early and late pregnancy affected the size of the young lamb and the development of the mammary gland.

Ewes from two groups on differing levels of feeding were killed after 91 days of pregnancy, when there was no difference in the size of the foetuses. At this time half the remaining group of ewes on the higher level of feeding was transferred to a lower level, where they lost in body weight. The remainder continued at the higher level of feeding.

Similarly half the remaining group on the low level were changed to a higher one, the others continuing at the same low level.

All the ewes on a higher plane of feeding for the last eight weeks of pregnancy, had much better developed mammary glands, when killed four days before parturition was expected. The twin lambs from the ewes on this higher plane were twice the weight of those on a lower plane for the last eight weeks of pregnancy.

In a similar experiment where lambs were born and reared, it was shown that, where the level of nutrition was lowered during the last eight weeks of pregnancy, many lambs died shortly after birth. These ewes produced only 30 lb. of milk per week as against 50 lb. by the high level group.

Pregnancy toxaemia also occurred in the group of ewes which were fat in mid-pregnancy and then changed to a low diet.

Although this series of experiments was carried out with ewes, the lesson is the same for other mammals, and undoubtedly in the field of animal husbandry the greatest value will come from its application to the dairy cow.

" Steaming up," as it is now termed, gives a most significant increase in the subsequent lactation, and this extra feeding before parturition is just as essential in the case of an animal in good as in poor condition, as the animal can utilize only immediately available food for the development of the udder tissues and cannot draw on her own body reserves for this purpose.

Unless " steaming up " is adequate the dairy cow will fail to show her true production, and proper selection for breeding purposes will be impossible.

The experiments also help to explain some of the reasons for the high mortality amongst newly born lambs from ewes which have lambed down in poor condition, a state of affairs only too well known in the hill flock. It was shown that although the ewes were killed on the 144th day from conception, the lambs from the ewes which had been on the low diet during the last eight weeks of pregnancy, were anatomically (and probably physiologically) only about 130 days old, whereas those from ewes on the good diet before parturition were some 160 days old, judged on a comparable basis.

Mortality is due probably to the heat regulation powers not being sufficiently well developed, since this body function develops only about the time of birth.

Growth and Development in the Pig. McMeekan, C. P. *J. agric. Sci.*, **30** (1940) and **31** (1941).

The experiments were carried out with an inbred strain of pigs in which the variation due to genetic causes was small. Growth was controlled by giving varying quantities of a well balanced ration.

Early developing parts of the animal, such as head, eyes, etc., have priority of food supply in pigs on a low diet, whilst later growing parts, such as loin and thorax, are much under developed. Pigs so fed are unable to express their true genetic capabilities.

During early life the muscular framework makes most rapid growth ; fat is laid down at a later stage. Good feeding is necessary in early life for adequate skeletal growth. Pigs stunted in early life and then well fed, produce small, fat carcasses. Good feeding in early life, and a limited but sufficient diet later, give a large framed, muscular pig with little fat. Two entirely different types are produced though genetically they are similar.

The experiments indicate the desirability of adequate nutrition for animals from which selection is to be made for breeding purposes. The necessary improvement required in the livestock industry cannot be reached by better breeding alone. Feeding and management should be at the optimum level ; otherwise the environment is lacking, and the animal fails to show its true genetic capabilities.

The importance of good rearing during the early life of the animal cannot be over emphasized, as animals which are at all stunted during this period cannot make up the necessary leeway later in life. Should the bone structure of the animal not be given its real chance of development, then, although conditions later may be at the optimum for flesh formation, the animal will fail to reach that standard of conformation which, by its breeding, it should have attained.

W.L.

ANIMAL NUTRITION

At a London Conference of the Nutrition Society in July, 1946, representatives from many parts of Europe reviewed the nutritional activities which took place in their countries during the war years both from the point of view of human nutrition and the feeding of domestic livestock. These reviews were published in the **Proceedings of The Nutrition Society, 5** (1947), 4.

From the farm livestock point of view all European countries suffered to a greater or lesser degree from shortages of coarse grains and high protein feeding stuffs, and it was natural that nutrition workers in each country should have examined their own natural resources to see to what extent these resources could be turned to good account.

In Norway, Sweden and Finland fodder cellulose prepared from wood was extensively used as an energy food for beef bulls, dairy cows, calves, sheep and horses. Professor K. Brierem records that in Norway alone during the period 1940-45 a total of 740,000 tons of cellulose was sold for fodder. It was estimated that cellulose had about the same net energy value as oats, and it was quite common to feed 7 lb. daily to milch cows and up to 11 lb. per day to horses. Professor Vartiovaara states that the feeding of wood cellulose to cattle and horses in Finland staved off the necessity for mass slaughter. Fodder cellulose is, practically speaking, a pure carbohydrate, and cannot be fed without appropriate supplements of proteins, minerals, and vitamins. These were supplied

usually in the form of silage made from green crops. The feeding of cellulose to pigs was not successful except with cellulose fodder made from straw and even then no saving of food was recorded. Feeding trials with straw pulp prepared by the alkali process gave similar results to those obtained in Great Britain in 1939. The cost of preparing fodder cellulose is high, and it is doubtful whether it is economic save under conditions of emergency.

The competition for food grains between humans and pigs and poultry led inevitably to a reduction in the population of the latter in countries such as Denmark, Holland and Switzerland. Nutritionists in these countries sought for a solution of their feeding stuffs supply problem in the use of substitute feeding stuffs and in the better conservation of fodders for winter use. Even before the war farmers on the Continent had made more extensive use of silage than we had made in this country, and during the war had to rely on this source of protein to replace the deficit caused by stoppage of imports of oil seed cakes. Dr. A. Schürch reported the results of conservation trials carried out at the Institute of Animal Nutrition, Federal Institute of Technology, Zürich, where a comparison was made of the percentage loss in starch equivalent of grass preserved by different methods. These losses amounted to 40 per cent. with hay cured on the ground, 35 per cent. when racks were used and 10 per cent. with grass silage and artificial drying. Effort was also directed to the solution of the difficulties arising in the manufacture of hard cheese following the increased use of silage for dairy cows. Milk from silage-fed cows appeared to contain a high content of butyric acid bacteria and this was related to the high content of these bacteria in the silage. Experiments were carried out with the object of producing silage with a low count of butyric acid bacteria, and it was found that an increase in the dry matter of the forage from 14.3 to 31 per cent. led to increased lactic acid fermentation and an improvement in the quality of the silage. Trials were also made in grinding the forage before ensiling, and excellent quality silage with no increase of butyric acid bacteria was made in experimental silos even though over-ripe clover was used in the absence of any preserving agent. It was also found that the lactic acid present had a more potent bactericidal effect at lower pH values. In Denmark Dr. Steensberg reported on the increased use of silage made from beetroot tops. If the tops were clean when gathered digestion trials with milch cows showed that 74 per cent. of the organic matter in the silage was digested as compared with 64 per cent. when the silage was made from dirty tops.

It has been known for many years that non-protein substances, such as urea, which can be manufactured from the nitrogen of the atmosphere, can partially fulfil the rôle of protein in the diet of ruminants. It was not surprising that workers in countries faced with a severe shortage of high protein feeding stuffs should examine again the possibilities of using urea in rations for dairy cattle, fattening bullocks and fattening lambs. Reports from Norway, Holland and the United States of America all agree that urea has a use in replacing part of the protein but that its value is limited and it is not likely to be used in practice when ordinary sources of protein are available. Bowstead and Fredeen (*Sci. Agric.*,

28 (1948), 2) have investigated the palatability of feeding mixtures containing urea, using dairy cows. They report that the individuality of cows is a potent factor in determining palatability, and that there was some evidence that Holsteins tolerated mixtures containing urea better than Jerseys. Attention is drawn to the fact that urea may affect the bacterial flora of the rumen since it has been shown that urea can exert a bacterostatic effect. Preliminary trials showed that the addition of cobalt chloride (0.05 grammes per diem) helped to restore appetite for the feeding mixtures containing urea. It has been suggested that cobalt influences the micro-organisms in the rumen, and it may be, that, in this particular case, cobalt counteracted the changes brought about by urea.

R.G.B.

DAIRY BACTERIOLOGY

Chemical Sterilization of Milk Utensils

For many years steam has been the medium of choice for the sterilization of dairy equipment and has been officially sponsored. Latterly, however, the ban on the use of disinfectants has been relaxed, but only in respect of hypochlorites. It has long been known that in liquids these substances are most active in acid solutions, the disinfectant efficiency declining rapidly with increasing alkalinity. The more acid solutions of hypochlorite caused rapid deterioration through rusting of, for example, milk churns, thus encouraging the accumulation of deposit and increasing the difficulty of sterilization. It is also well known that simple alkaline detergents such as soda ash, washing soda or sodium silicate facilitate the removal of milk residues from surfaces.

Work recently published (F. K. Neave and W. A. Hoy, *J. Dairy Res.*, **15** (1947), 1 and 2), has shown that on metal surfaces bearing milk residues (as in practice they almost invariably do) the disinfectant power of hypochlorites (Ca. 200 p.p.m. av. Cl.) in alkaline solution, up to pH 10, was, for common non-sporing organisms, at least equal to that at neutrality. This is directly contrary to what happens in liquids but has been confirmed by Cousins, S. M. and Wolf, J. (*Proc. Soc. Agric. Bacts.* : *Proceedings* 1946 : *Nature*, **158** (1946), 755), who also found that spores on surfaces are much less rapidly killed by alkaline hypochlorite solutions. Thus vegetative cells and spores behave differently. The findings of these workers have been incorporated in Ministry pamphlets and are now common practice. From the practical viewpoint it is highly important to observe the concentrations and times of application recommended and to keep surfaces clean and in good condition. Valuable discussion on the use of hypochlorites in America is given by Hall, H. S. and Rowlands, A. in *Agriculture Overseas Report*, No. 5, H.M.S.O., 1947.

Cheese Starters

During the late war much disruption of factory routine and loss of cheese was caused by the destruction of starters by bacteriophage. Improvized methods of coping with the trouble were devised and the

difficulties largely surmounted. In addition to that caused by bacteriophage further trouble followed the growth, in the milk used for cheese-making, of common non-pathogenic milk souring streptococci which produced antibiotic substances, inhibiting the growth but not disrupting the cells, as in bacteriophage attack. These organisms, derived from dirty utensils, have acquired more general interest, since the antibiotic substances they produce are active against many pathogenic organisms including the tubercle bacillus. (Mattick, A. T. R. and Hirsch, A. *Lancet*, **253** (1947), No. 6462.)

On closer examination of starter cultures it was found (Hoyle, M. H. and Nichols, A. A., *J. Dairy Res.*, **15** (1948), 3) that many contained strains of *Str. cremoris* which themselves inhibited other strains of the same organism. This means that in the selection of cultures for cheese-making in which mixtures are used, all must be tested for the presence of inhibitory (antibiotic) substances. This observation is of obvious importance in starter management and holds with *Str. lactis* as well as with *Str. cremoris* strains.

A.T.R.M.

DAIRY HUSBANDRY

U.S.A. Dairy Herd Improvement. *Dairy Herd Improvement Association Letter*, **23** (1947), 11.

In October, 1947, the United States Bureau of Dairy Industry compiled a proved-sire record for the 20,000th sire to be proved since the scheme began in 1945. The 305-day lactation records for yield and butterfat standardized to a mature equivalent twice-a-day milking basis for at least 5 dam-daughter pairs are recorded. It is noteworthy that details are published of bulls which produce daughters with records lower than their dams as well as bulls that increase production.

Linearity of regression of milk energy on fat percentage. Overman, O. R. and Gaines, W. L. *J. Anim. Sci.*, **7** (1948), 55.

New evidence is presented on a controversial subject : whether the regression of milk energy per unit milk on fat percentage is linear or not. It appears that a concave line fits the data best, but the quantitative difference between the linear and curvilinear regression lines is very small. Thus for general application the usual estimation of milk energy in terms of 4 per cent. milk by the formula $FCM = .4M + 15F$, although based on linear regression, is sound.

(FCM = Fat corrected milk, M = Weight of milk, F = Weight of fat.)

The heritability of official type ratings and the correlation between type ratings and butterfat production of Ayrshire cows. Tyler, W. J. and Hyatt, G. Jr. *J. Dairy Sci.* **31** (1948), 63.

Variations in type ratings of individual Ayrshire cows. *Ibid*, 71.

Data are presented to show that one third of the observed superiority of parents' type is inherited by the offspring, and that improvement in the type of dairy cattle can be effected by selection of animals above the herd average in type for parents of the next generation.

A highly significant correlation was found between type classification rating and butterfat record of a cow. Within herds there was an average increase of 13 lb. of butterfat for each increase of one grade in type.

Milk Marketing Board. *Report of the Bureau of Records.* 1948. (Mimeographed.)

The report gives details of activites of the newly instituted Bureau of Records, and points to the direction in which expansion is contemplated. It also gives details of preliminary studies on standard lactation length, various factors affecting a cow's milk yield, e.g. length of dry period and interval between calving, length of life of recorded cows, and the effect of age upon yield. Such information will be invaluable to all those concerned with milk production, and dairy husbandmen will look forward to further publications from the Bureau of Records.

The effect of penicillin upon the livability glycolysis and bacterial content of bovine semen. Almquist, J. O., Thorp, W. T. S. and Knodt, C. B. *J. Dairy Sci.*, **31** (1948), 11.

Penicillin added to diluted bull's semen, at the rate of 250 to 750 Oxford units per ml. diluted semen, did not reduce the ability of spermatozoa to maintain motility. Higher concentrations reduced the livability of spermatozoa. All levels of penicillin retarded bacterial growth in the diluted semen.

Science in Farming, 1947. United States Department of Agriculture, Washington.

An up-to-date survey, with literature references, of work in the United States on the following subjects connected with milk production is authoritatively presented : *Breeding better livestock*—Phillips, R. W. ; *Artificial breeding*—Phillips, R. W. ; *Thyroprotein for cows*—Moore, L. A., and Sykes, J. F. ; *Breeding better cows*—Fohrman, M. H. ; *The inside of a dairy cow*—Swett, W. W. and Matthews, C. A. ; and *A cow a calf will be*—Swett, W. W.

The last paper describes the very interesting method of selecting dairy calves on the basis of mammary development of the heifer calf at 3 to 4 months of age, which has been shown to be correlated with the heifer's later productive ability.

The Relationship of Mammary Development and Body Weight. Schabinger, J. R. and Knodt, C. B. *J. Dairy Sci.*, **31** (1948), 95.

A highly significant correlation was found to exist between development of the mammary secretory tissue and body weight in Friesian and Guernsey calves at 3 months old.

Handbook of Mechanical Milking. Whittleston, W. G. *N.Z. Dept. Agr, Bull.*, 260. *Reprinted* 1947.

Details are given of the construction and operation of the modern milking machine of the releaser type normally used in New Zealand. Apart from the engineering aspect of machine milking the author has given consideration to the newer knowledge of the physiology of milk

secretion and ejection in relation to milking. The " let down " of milk by the cow is a conditioned reflex, and a discussion of this in a bulletin dealing with mechanical milking is evidence of a real effort to advance the science of milking.

Efficient Dairy Chore Practices (Chore travel in Dairy Barns) Part I. Holmes, J. C. *New Hampshire Agric. Exp. Sta. Circ.* 72 (1946).

Using diagrams and with the help of formulae, estimations are given for the distances travelled in cowsheds while carrying milk, feeding silage and disposing of manure. Comparative figures are supplied assuming the dairy and/or silo to be either at the end, side end, or side middle with the cows facing either inwards or outwards. For a double standing, 40 stall cowshed, the total daily travel was estimated at 5,879 ft. when the cows face outwards and the shed is well arranged. The travel for the same cowshed under a poor arrangement of milk house, silo, etc., was estimated at 8,599 ft.

Efficient Dairy Chore Practices, Part II. Rapid Milking. Woodworth, H. C., Merrow, K. S. and Holmes, J. C. *New Hampshire Agric. Exp. Sta. Circ.* 76 (1947).

Studies were carried out with a number of commercial dairy herds using milking machines to find the time taken to milk and carry out the various operations associated with milking. In 30 herds the average duration of milking was 6 minutes per cow, the lowest herd average was 3.5 mins. and the highest 9.6 mins. Following advice from the extension service, 31 herds successfully adopted the " quick milking " routine ; these represent 30 per cent. of the herds where an attempt was made to adopt the routine. 92 per cent. of the 693 cows in these selected herds were milked in 4½ minutes ; no details are given of the number of slow milking animals culled from the herds prior to timing nor the reason why 70 per cent. of the farmers failed to adopt the quick milking routine. Valuable advice is given on labour utilization in the cowshed and routines for various numbers of men and machines. Admittedly much time can be saved by efficient organization of labour and by removing the teat cups as soon as milk ceases to flow, but the authors' other claim that cows can be trained to milk more quickly is open to question.

Lead Poisoning of Calves. White, E. G. and Cotchin, E. (*Veterinary Journal*, **104** (1948), 3, 75-91).

The authors discuss 27 cases of probable or proved lead poisoning in calves aged 2-40 weeks. In 16 cases flakes of blackened paint were found in the stomachs, 19 calves showed symptoms of lead poisoning before death ; these were convulsions, blindness, bellowing and salivation. In less acute cases the animals were dull and unthrifty. Typical symptoms were produced experimentally in calves fed on lead paint from premises where natural cases had occurred, on other samples of lead paint, and by feeding lead carbonate to the calves. Calves are very susceptible to lead poisoning and should be kept away from all lead-paint coated objects. If paint has to be used, use a lead-free one. (See also White and Cotchin *Agriculture*, **51** (1944), 85-86.)

An Improved Chemical Dehorning Agent for Young Calves. Guthrie, J. E. *Vet. Med.*, **42** (1947), 284.

Forty-eight calves were successfully dehorned by applying a mixture of salycylic acid, antimony trichloride and flexible collodion to the hornbud within 14 days of birth. The hair is removed from the bud and the mixture (a syrupy liquid) is painted on ; it quickly sets, forming a water-proof cap. Destruction of the underlying tissue takes place slowly and there is no " weeping " or oozing of fluids from the horn bud. A hard brown scab forms, falling away about a month after treatment leaving a surface almost completely healed. It is claimed that the solution causes little pain or irritation. It is understood that a dehorning material similar to that described is coming on the market in Britain immediately. It should be noted that the liquid is poisonous.

Lactation : Function and Product, Part I. *British Medical Bulletin*, **5** (1947), 123-219.

Contributions from specialists, who give up-to-date reviews of the knowledge of milk, its production, processing, distribution and control, are brought together in this symposium ; it is divided into eight parts. Of interest to agriculturalists are (1) Physiology of Lactation, (2) Stimulation, Induction and Inhibition of Lactation, (3) Nutritive Qualities of milk, (6) Bacteriological and Chemical Control of Milk, (7) Handling and Control of Milk, (8) Literature on Lactation and Milk. Though this symposium was intended for the medical profession it is an invaluable source of information for the agricultural scientist. Particularly valuable are the reviews dealing with the histology of the mammary gland, the endocrine control of mammary development and lactation, the nervous system and lactation and the induction and stimulation of lactation by artificial means. The comprehensive bibliography of British books and journals dealing with these subjects is a very valuable addition to the series of articles.

A.S.F.

POULTRY

Feeding

With the continued restrictions of animal feeding stuffs, several recently published papers on the efficiency of food utilization by poultry will be of particular interest to Advisory Officers in this country. Hess and Jull (*Poultry Science*, **27** (1948), 24-39) in a paper entitled *A study of the Inheritance of Feed Utilization Efficiency in the Growing Domestic Fowl* demonstrate that there is a definite inherited difference in the power of individual birds to utilize food. They point out from the data presented that male chickens are slightly more efficient in utilizing food than females, and that cross-bred birds also manifest the same superiority when compared with pure bred chicken produced by a common sire. It appears from their researches that inbreeding has a depressing effect on the efficiency of food utilization, but that fast-growing birds utilize food more effectively than slow-growing stock. The authors of the paper consider the mode of inheritance to be a complicated genetical

problem, but their statement that of the two flocks of different breeds employed in the experiment, the New Hampshires showed a greater measure of efficiency than Barred Plymouth Rocks, is of some interest. This statement is of particular significance in this country where few New Hampshires exist, and suggests that more consideration might be given to possible variations between breeds from the viewpoint of the present shortage of food and the poultryman's profit in the future. This is further emphasized by the recent development in Western Canada where hatcheries are showing greater interest in New Hampshires at the cost of Rhode Island Reds (the most common breed in this country) because of the view now held there that the New Hampshire produces a greater weight of eggs per quantity of food consumed. In the same Journal an article by McCartney and Jull confirms the previous authors' findings that the efficiency of food utilization is an inherited trait, although they suggest that the difference between strains diminishes after 10 weeks. This would suggest that breed variations may be of greater concern to the table poultry keeper.

Another paper dealing with feeding efficiency is that by Lillie and Briggs (*Poultry Science*, **27** (1948), 7-11) entitled *The Use of Semi-Solid Vegetable Wastes in Poultry Rations*. The co-authors found that the material, when fed with a ration deficient in vitamin A, was an excellent source of carotene for poultry—and moreover they point out that vegetable waste appears to possess some growth promoting factor other than vitamin A, since feeding semi-solid vegetable matter led to greater growth than when chicken were fed the same ration fortified with alfalfa leaf meal as a source of vitamin A.

Vitamin A is also the subject of a recent paper by Temperton and Dudley (*Harper Adams Utility Poultry Journal* (N.S.), **32** (1947), 83-110) in which the authors put forward data to support their view that preformed vitamin A (shark liver oil origin) when included in mash mixture is an unreliable source of supply of this essential vitamin. The authors argue that this is so, because of their finding that the biological activity of their vitamin was rapidly and extensively destroyed by a factor which appeared to be present in the ether extract of the basal mash. This rather disturbing paper would suggest the urgent need of getting young chicks and adult stock on good herbage as early as possible; the views of these authors are not entirely accepted by certain nutrition specialists.

Another noteworthy paper on feeding is that by Wheeler, Hoffman and Graham (*Poultry Science*, **27** (1948), 103-111) on thyro-protein in rations. Various papers have latterly been published seeking to establish the value of stimulations produced by the feeding or the injection of various body secretions. The findings so far are of practical value to the table poultry trade alone. This will be obvious since continuous treatment to achieve permanent results would probably be financially impracticable to the egg producing section of the industry. Wheeler and his co-authors fed a diet containing 10 gms. of thyro-protein (3 per cent. thyroxin) per 100 lb. of food. The results showed that the birds developed an earlier feather growth and with the males exhibited a highly significant increase in uniformity of body weight, as well as an all-round increase of body weight, at 12 weeks. A related paper in the

same Journal is that by Davis and Thayer dealing with the finishing of market turkeys with estrogens. The estrogen—female sex hormone—used in this case was dianisyllhexene. Birds of both sexes which were treated showed a remarkable improvement in flesh condition and a considerable gain in body weight. Mortality was unaffected.

Users of present day poultry foods may derive some consolation from a paper by Davis and Briggs (*Paper* 182, *Maryland Experimental Station*). The authors found that sawdust fed at a 10 per cent. level led to a significant increase in growth. The sawdust was fed in a purified diet at the expense of glucose. Increases above 30 per cent. depressed growth and led to a lowered utilization of food. The authors are careful to point out, however, that most diets contain sufficient cellulose, and our present National mashes call for no addition of cellulose in the form of sawdust.

Breeding

Two papers dealing with plumage changes are of interest to the pedigree breeders. Punnett, in the *Journal of Genetics*, **48** (1948), No. 3, comments upon a hitherto unrecorded type of cream plumage. This plumage appears to behave as a simple recessive. Punnett concludes that silver, gold and cream do not constitute an allelomorphic (alternative types) series in the sex chromosomes, but that the three types of plumage depend upon two allelomorphic pairs, of which one is located in the sex chromosome, while the other is in an autosome. McGinnis and Carver in *Poultry Science*, **26** (1947), 457-462, discuss the effect of calcium deficiency on feather colour in New Hampshires. These authors consider that a deficiency of calcium causes a striking increase in the amount of black in the under colour, a matter which is not of any economic importance but will be of interest to those pedigree breeders who pay considerable attention to breed type.

R.C.

CROPS AND PLANT BREEDING

Hormone weed-killers

Most of the so-called hormone weed-killers are based on 2,4–dichlorophenoxyacetic acid (2,4–D), a synthetic chemical which is more stable than the naturally-occurring growth regulating hormones of plants. Fults and Payne (*J. Amer. Soc. Agron.*, **39** (1947), 667-681) have investigated other chemicals in respect of growth-regulating and herbicidal properties, estimating their effects quantitatively over a range of concentrations and comparing them, under statistical control, with 2,4–D. Using the pea test, in which the effect measured is the curvature produced in the split stems of young pea plants, they studied the growth-regulating activities of 74 chemicals. A selection of these, totalling 26, was studied in a test which they devised for herbicidal activity, using castor bean as a test plant. As might be expected (since herbicidal activity is closely connected with growth regulation), the two tests agreed reasonably well, but not sufficiently well to enable complete reliance to be placed on either. Many of the compounds tested were chemically

related to 2,4–D, and certain of them were found to be stronger. Included in the tests were some animal hormones, some fungicides and the well-known insecticide DDT. Two animal hormones, two fungicides and DDT were found to be comparable to 2,4–D in growth regulating activity.

A rather disturbing feature of 2,4–D herbicides is their effect of suppressing nodule formation in leguminous plants. Carlyle and Thorpe (*J. Amer. Soc. Agron.*, **39** (1947), 929-936) have studied this effect in some detail and found that beans (*Phaseolus*), peas, red clover and lucerne all showed marked reduction in number of nodules produced when treated with ammonium or sodium 2,4–dichloro-phenoxyacetate in concentrations down to 0.007 parts per million. The highest concentrations used, 0.5 p.p.m. corresponding to 0.21 lb. per care, also caused thickening and shortening of the roots and some inhibition of germination. The ammonium salt had a stronger effect than the sodium salt. The effect of these salts on the *Rhizobium* species, which induce and inhabit the nodules, was of a very different order : in culture media, a concentration of 0.03 per cent. was needed to produce any noticeable inhibition. The reassuring conclusion is therefore indicated that 2,4–D inhibits nodulation because of its effect on the plant and not because of any effect on the *Rhizobium*, which would apparently be quite immune to the concentrations normally used in the control of weeds. In other words, the use of 2,4–D is not likely to have a permanently adverse effect on eguminous crops coming later in the rotation.

Seeds

Germination Tests.—Much work has been done by plant physiologists and seed analysts on the development of rapid tests for germination capacity. Such tests are based on detection of the activity of enzymes concerned with oxidation. A very promising test was developed by Eidmann, using the colour of the surface of the embryo after treatment of the seed with sodium biselenite ($NaHSeO_3$). Johnston (*J. Amer. Soc. Agron.*, **39** (1947), 943-947) has tried this method in comparison with more conventional germination counts with some 24 species and concludes that the method is fundamentally sound. His procedure is a slight modification of Eidmann's and is as follows : (1) soak the seed in water for 16 hours ; (2) drain and aerate it under moist conditions for 8 hours ; (3) soak it in 2 per cent. sodium biselenite for about 24 hours. The embryos are then excised and classified into four groups : (1) with the entire surface dyed a rich red ; (2) intensively dyed only in parts but with no part of the surface entirely uncoloured ; (3) weakly dyed throughout or with less than $\frac{2}{3}$ of the surface uncoloured ; (4) not dyed at all or dyed weakly over $\frac{1}{3}$ or less of the surface area. The proportion in classes (1), (2) and (3) represents the proportion capable of germinating at all of which those in (3) would not be likely to emerge in the field. Class (4) represents non-germinable or dead seed.

Seed Growing—The Avoidance of Contamination.—In growing seed crops of cross-pollinated crop plants, the commercial method of avoiding contamination by pollen of related crops possessing similar

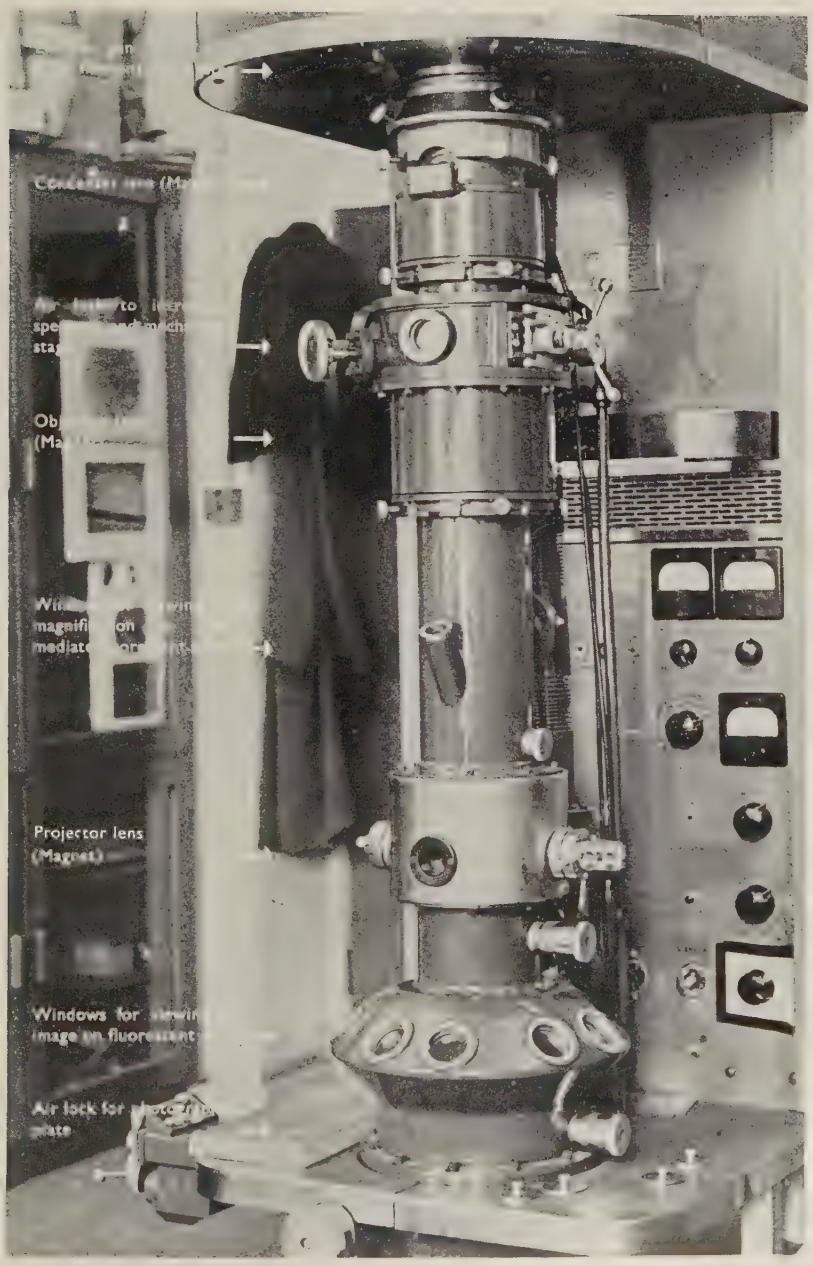


Fig 1. The Electron Microscope. *(Photo: R. Markham.)*

Fig. 2. The virus of tobacco mosaic photographed on the Electron microscope. Note that the virus particles are long rods. (*Cosslett and Markham.*)

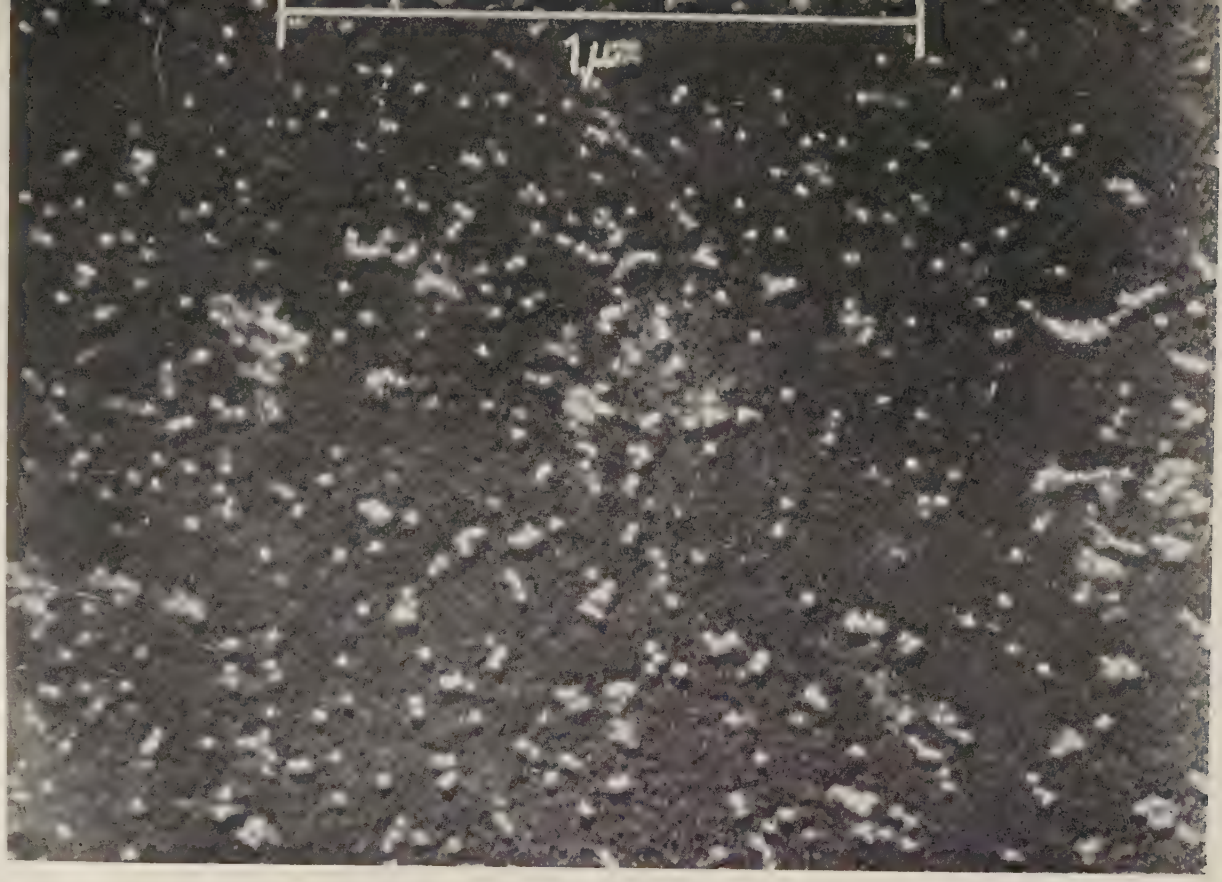


Fig. 3. The virus of turnip yellow mosaic photographed on the Electron microscope by the gold shadow technique. Note that the particles are spherical. (*Markham and Smith.*)

Fig. 4. Crystals of the turnip yellow mosaic virus. *(Markham and Smith.)*

flowering periods is isolation by distance. Bateman (*J. Genet.*, **48** (1947), 257-275 ; *Heredity.*, **1** (1947), 235-246) has studied this quantitatively in both insect-pollinated crops (turnip and radish varieties) and wind-pollinated crops (beet and maize varieties), and finds that the effect of distance is similar in type in both classes. Each successive increment in distance from the contaminating variety brings about a decrease in contamination, but the rate of decrease declines with increasing distance. In maize, differences in time of flowering of contaminator and contaminant and of tasseling and silking in the contaminant caused variations independent of distance. Contamination was greater and extended further to leeward than to windward. He concludes that the distance requirements for isolation may be regarded as similar in both insect-and wind-pollinated crops, provided that the greater range of some wind-borne types of pollen is compensated for by increasing the size of plots liable to contamination. Practical recommendations are given by the John Innes Horticultural Institution (*The Fruit and the Soil, Collected Edition of the John Innes Leaflets*, 1948).

Cereals

Grazing of Autumn-sown Crops.—At Knoxville, Tennessee, the effects of autumn and spring grazing on erect and prostrate varieties of autumn sown oats, barley, wheat and rye were determined by Washko (*J. Amer. Soc. Agron.*, **39** (1947) 659–666) in an experiment covering the three seasons 1943-1946. Using split plots the effect of grazing on grain yield, plant height, tillering and maturity were determined. The weight of forage removed was estimated by caging, and in 1945-46 the dry matter, crude protein, lime and phosphate of the forage were determined. In forage production rye excelled all other cereals ; erect varieties produced about the same as prostrate. The percentage reduction in grain yield varied from 23.2 to 46.7, prostrate types suffering less than erect, except in rye. Plant height and tillering were reduced by grazing and maturity was postponed from 4 to 8 days. The forage was high in protein, lime and phosphate, the autumn forage being superior to the spring. The stock preferred oats to all the other cereals.

Wheat Breeding.—In a study of methods in wheat breeding, Boyce, Copp and Frankel (*Heredity*, **1** (1947), 223-233), using F_2 and F_3 generations of a compound cross [(F$_1$ Holdfast × Tainui) × Cross 7,] concluded that selection by the components of yield (number of ears per plant, number of grains per ear and weight per grain) did not improve the efficiency of selection. Selection for length of straw had a slight adverse effect on efficiency of selections for yield. Comparing selection for yield based on eye judgment with that based on weighing, they found that eye selection was more efficient with single F_2 plants than with F_3 cultures, and was the more efficient the higher the intensity of selection; its efficiency was also increased by utilizing the judgment of more than one observer. Eye selection was as effective as selection by weighing in raising the average yield in F_3.

Maize Stalks as a Source of Sugar.—An interesting note by Singleton (*Science*, **107** (1948), 174) reports the occurrence of 11.25 per

cent. sugar (of which 8.65 per cent. was cane sugar) in the stalks of an inbred line of field maize. This discovery may reopen the question of producing sugar from maize on a commercial scale, as the Aztecs used to do. Should this be developed in the U.S.A. it is just possible that it would also be successful in England.

Potato

At a meeting of the Association of Applied Biologists, Hawkes (*Ann. app. Biol.*, **34** (1947), 622-631) gave a summary of the taxonomy, pathology and cytology of the South American potato species, based to a large extent on work on the Empire Potato Collection at Cambridge, with special reference to their possible use in the ultimate improvement of the domestic potato. Black (*Ibid*, 631-633) gave genetical data on the inheritance of resistance to blight. Working with resistance derived from *Solanum demissum*, and using the three distinct strains of *Phytophthora infestans* known in Great Britain, he postulates a number of dominant factors for resistance and suggests that to account for variations in results from year to year it is necessary to assume that quantitative as well as qualitative differences in virulence of *Phytophthora* strains occur.

Hops

In view of the impracticability of arresting the spread of Verticillium wilt (*Verticillium albo-atrum*) by field sanitation, Keyworth (*J. Pomol. Hort. sci.*, **23** (1947), 99-108) has investigated the resistance of new varieties. Varieties showing resistance in primary selection trials were tested in infected gardens, with the hopeful result that certain of the Wye varieties bred by Salmon and one bred on a commercial farm were classified as resistant.

J.L.F.

HERBAGE

Conservation of Herbage. Homes, W. *Agr. Prog.*, **22** (1947), 79 ; Rea, Eric. *Ibid*, 87.

The programme for increasing agricultural production in Britain by 20 per cent. during the next four years has been accompanied by efforts to improve the utilization of grass, particularly in relation to methods of grass conservation. Owing to the high wastage that normally accompanies haymaking an increase in the proportion of grass conserved as silage has widely been advocated. Stapledon (*Agriculture*, **54** (1948), 433) considers that grazing plus haymaking is not all-sufficient in utilizing ley herbage to the best advantage and all-out ley farming must be accompanied by an additional method of conservation.

Emphasis has been also placed upon the nutritive value of silage made from suitable forage, while it is stressed that grass should be ensiled when relatively young and of high protein content and still of high digestibility.

Particular attention has been given to those aspects of ensiling which renders the process foolproof and practicable under a wide variety of farm conditions.

Considerable reduction of human labour accompanies pit- and trench-made silage, particularly when the material is transported by buckrake or near mounted sweep. Wastage in ensiling, which has been reported to be one of the main reasons for the slow expansion of silage making (Moore, H. I. *Agriculture*, **54** (1947), 385), can be kept at a satisfactorily low proportion in pit and trench silos under conditions whereby consolidation is readily effected by running tractors and vehicles over the ensiled mass.

Seeds Mixtures

The use of simple seeds mixtures is being widely adopted, and concurrently the complementary use of differing simple seeds mixtures is being developed to provide sequential grazing. The provision of nutritious grazing from midsummer to early autumn is difficult in certain years and parts of Britain. Davies (*Agriculture*, **54** (1948), 438) advises the use of a simple mixture of 12 lb. S.37 cocksfoot and 2 lb. S.100 white clover per acre to fill this " summer gap." Suitable pre-management is stressed, and such leys are best allowed to go to a very early hay or silage cut prior to be allowed to grow to give suitable bulk and quality of grass in July and August. Lucerne, with a suitable companion grass (cocksfoot, timothy or meadow fescue where it can be grown), can equally well provide grazing during this period.

Similarly, with the necessary management, leys based on leafy strains of cocksfoot can be used to extend the grazing into late autumn and early winter while mixtures of leafy strains of timothy and meadow fescue can carry autumn growth of herbage still further into the winter period in a nutritious condition.

T.E.W.

The yield, botanical and chemical composition of natural hill herbage under manuring, controlled grazing and hay conditions. I. Yield and Botanical section—Milton, W. E. J. **II. Chemical section**—Davies, R. O. *J. Ecol.*, **35** (1947), 65.

This is a report for the years 1940-1946 (this experiment was started in 1930), and the results for the earlier years have previously been published.

The manurial treatments were as follows :

Pasture plots, fenced and unfenced

(1) Ground limestone at 2 tons per acre applied every fifth year = plot Ca. (2) Superphosphate at 4 cwt. per acre per annum = plot P. (3) As (2) plus 4 cwt. kainit and 1 cwt. sulphate of ammonia per acre per annum = plot PKN. (4) As (3) plus ground limestone as (1) = plot CaPKN. (5) Control.

TABLE I

Centres (enclosed areas)	Fine-leaved fescue	Bent (*Agrostis*)	*Molinia*	*Nardus*	Other grasses	Wild white clover	Herbs
(1) Bwlchrosser—fescue-bent pasture	53	33	—	—	5	T	9
(2) Llety—fescue-bent pasture	65	20	T	2	3	—	10
(3) Llety—*Molinia* pasture	17	1	71	6	—	—	5

TABLE II

Per cent. contribution of individual species to total yield in 1944 with relative total yields ; control=100 at 3,681 lb. per acre. (Bwlchrosser fescue.)

Plot	Native species				Volunteer species				Herbs %	Relative Yield %
	Fine-leaved fescue %	*Agrostis* spp. %	Other grasses %	Yorks. fog %	Smooth-stalked meadow grass %	Rough-stalked meadow grass %	Other grasses %	White clover %		
CaPKN ...	43.1	3.7	—	4.9	30.4	14.7	T	3.2	—	240
PKN ...	12.0	60.0	—	7.5	11.2	5.1	4.2	—	—	214
Ca	25.0	10.4	—	1.8	25.5	12.5	0.3	14.0	10.5	205
P	33.5	33.4	T	4.9	10.9	9.8	—	5.8	1.7	159
Control ...	24.8	48.0	10.2	T	8.2	—	—	—	8.8	100

Hay with aftermath plots

(1) Manures as for (4)=CaPKN. (2) Control.

The results of the fenced pasture plots only are described in this abstract.

The manurial and management treatments were carried out on three hill swards and at the beginning of the experiment in 1930 the contribution of the constituent species was as shown in Table I.

Since the experiment began, the botanical changes in the sward have been continuous. There were particularly rapid changes in the *Molinia* sward and with complete manuring, CaPKN and PKN, fescue and *Agrostis* completely dominated the herbage after two years and *Molinia* almost disappeared. In the fescue-bent swards there has been a gradual change towards bent dominance under certain treatments, an increase of herbs and a varied flora in the lime plots while, in 1934, certain lowland species appeared, particularly Yorkshire fog, rough- and smooth-stalked meadow grass and wild white clover, the greatest change occurring under complete manuring. In the later years, perennial ryegrass, cocksfoot and timothy have appeared in small quantities.

THE CONTRIBUTION OF THE INDIVIDUAL SPECIES TO THE YIELD IN 1944

Bwlchrosser fescue pasture.—The controlled and regular grazing has increased the proportion of bent in the no manure plot. The volunteer species, mainly rough and smooth-stalked meadow grasses, now contribute approximately 53-55 per cent. in the CaPKN and Ca plots, while bent is the dominant species in the PKN plot and co-dominant with fine-leaved fescue in the P plot. Wild white clover contributed most in the Ca plot (see Table II).

The yield in plots CaPKN, PKN and Ca has been more than twice as great as the control plots, and accompany a marked increase in the proportion of better grasses, in this instance, *Agrostis*, rough-and smooth-stalked meadow grass.

Llety fescue pasture.—The botanical changes in this sward have been similar to the above, with also a more marked decrease in the proportion of fine-leaved fescue, a greater ingress of rough-stalked meadow grass than smooth-stalked meadow grass, and a higher contribution of wild white clover in plots CaPKN and PKN. Bent has contributed very substantially to the yield in the PKN and P plots (see Table III).

Llety-Molinia pasture.—Under the controlled grazing of the experiment, the no manure plot has changed from *Molinia* to fescue dominance. In 1944 *Agrostis* was the dominant species in the P plot and shared dominance with Yorkshire fog in the PKN plot and this latter species was dominant in the CaPKN plot and also a major contributor in the P plot. Rough-stalked meadow grass was very plentiful in the CaPKN, Ca and P plots. Similar to the other centres white clover was plentiful only in the CaPKN and Ca plots (see Table IV).

TABLE III

PER CENT. CONTRIBUTION OF INDIVIDUAL SPECIES TO TOTAL YIELD IN 1944 WITH RELATIVE TOTAL YIELDS : CONTROL=100 AT 1,998 LB. PER ACRE. (LLETY FESCUE)

Plots	Native species				Volunteer species				Herbs	Relative Yield
	Fine-leaved fescue	*Agrostis* spp.	Yorks. fog	Other grasses	Smooth-stalked meadow grass	Rough-stalked meadow grass	Other grasses	White clover		
CaPKN ...	T	4.7	2.0	—	14.0	49.9	2.4	27.0	T	217
PKN ...	T	81.6	15.9	T	T	0.8	1.7	—	—	150
Ca	4.0	5.2	1.2	T	8.1	50.5	1.1	28.2	1.7	124
P	4.6	53.3	T	T	—	34.3	4.1	3.7	T	156
Control ...	62.8	26.2	—	3.4	—	—	—	—	7.6	100

TABLE IV

PERCENT. CONTRIBUTION OF INDIVIDUAL SPECIES TO TOTAL YIELD IN 1944 WITH RELATIVE TOTAL YIELDS : CONTROL=100 AT 2,300 LB. PER ACRE. (LLETY MOLINIA)

Plot	Native species					Volunteer species					Herbs	Relative Yield
	Molinia	Fine leaved fescue	*Agrostis* Spp.	*Nardus*	Sweet vernal	York. fog	Rough stalked meadow grass	Smooth stalked meadow grass	Other grasses	White clover		
CaPKN... ...	—	6.6	16.1	—	—	41.9	—	23.2	2.0	10.2	—	422
PKN	—	—	45.9	—	—	41.7	—	3.7	8.7	—	—	316
Ca	—	3.9	11.0	T	—	16.2	5.9	30.5	5.3	14.5	12.7	293
P	T	4.6	38.0	—	5.2	31.4	T	20.4	0.2	0.2	T	252
Control	6.4	54.1	23.2	14.2	—	—	—	—	T	—	2.1	100

All manurial treatments on this sward type produced greater yield responses than on other sward types, the complete manuring CaPKN producing over four times the yield of the no manure.

At all the centres the controlled grazing alone brought about marked sward changes. The better utilization of herbage and the increased stocking resulting from good utilization improved the general productivity. However, without manuring there has yet been no appearance of volunteer species. The latter have appeared only on the manured plots and there has been a progressive increase in volunteer species and herbage yield. As yet the chief volunteer species have been Yorkshire fog, rough- and smooth-stalked meadow grass and white clover. Perennial ryegrass, cocksfoot and timothy have become established in the fertilised plot, but so far have contributed only slightly to the yield. The influence of controlled grazing was to accelerate the botanical and productivity changes.

T.E.W.

NUTRITION OF HORTICULTURAL CROPS

Summary of Present Knowledge

As future abstracts will deal with specific horticultural problems in this country an outline of the main principles and nomenclature to be followed may prove to be a useful introduction. All horticultural crops require both major and micro-nutrients ; the latter term is preferable to the use of others such as " minor " or trace elements. The major elements are nitrogen, phosphorus, potassium, calcium, sodium, magnesium and sulphur, whilst the micro-nutrients proven so far are, boron, copper, iron, manganese, molybdenum and zinc.

The desideratum in all nutritional work is the determination of the optimum manurial conditions and treatment in relation to the ultimate quantity and quality of the crop. Many field experiments have been carried out to determine these conditions particularly for fruit, glass-house tomatoes and some vegetables. During the last ten years considerably more attention has been paid to the nutrient deviations in the plant from the optimal, which in everyday practice are known as deficiencies and excesses. For example, a soil, by virtue of its nature or as a result of certain environmental conditions, might show a deficiency of, or an excess of, any major or micro-nutrient. In the major nutrient group deficiencies of all the elements given, apart from sulphur, may occur, whilst in the micro group, all those mentioned, apart from zinc, have been recorded in this country. The problems associated with excesses of these nutrients arise naturally, apart from that of molybdenum, in strongly acid soils, and artificially by the spreading of spoil heaps from heavy-metal mine workings, from sewage effluents derived from industrial areas, from industrial fumes and lastly by the too generous application of fertilizers over a number of years.

Whilst deficiencies and excesses of any particular nutrient may occur singly, they also may occur as " multiple " cases in which a complex nutrient status may exist involving an excess of one nutrient and a

shortage of another. The diagnosis of the latter involves the use of a number of complementary methods, including the visual method, tissue tests, chemical and spectrographic analyses, micro-biological methods and field experiments. The use of one method alone may suffice to diagnose the more common problems of orchards, market gardens, and glasshouses, but frequently it is the integration of the different techniques which has to be used.

Finally, the cure and prophylaxis of nutritional disorders are continually extending or being improved. For instance, where fertilizers are applied to the crop at sowing time, the use of fertilizer placement, particularly in the form of " band " placement, for horticultural seeds will probably have much to commend it when suitable implements have been developed. On the other hand some of the major and micro-nutrients are preferably sprayed on to the crop, and as a corollary to this method the inclusion in overhead irrigation of appropriate nutrient solutions is already being adopted. The perennial crops, such as top fruits, lend themselves to the solid injection of nutrient salts into the trunk or branches, whilst perhaps the latest allied technique is the liquid injection of nutrient solutions into the soil. Thus, injection in the latter way could be used both for annual and perennial crops, and in this respect promises to be a method of wide application.

The brevity of this summary limits the mention of all those other factors which affect the issues raised here, but in the main, horticultural crop nutrition, which is so diverse because of the great range of annual and perennial crops, depends, for the most part, on an understanding of the physiological needs of the plant in relation to its environment.

W.P.

FRUIT

Prevention of Spring Frost Damage

A summary of existing literature on the subject, prepared by the Imperial (now Commonwealth) Bureau of Horticulture in 1945, was published as *T.C. No.* 15, *Spring frost damage in orchards and its possible prevention*. It deals shortly with the physiology of frost injury, and the factors, both inherent in the plant and of environment, that affect frost resistance, and mainly with methods and apparatus for preventing damage. The latter range from indirect methods (e.g., the breeding of resistant varieties, spraying or injecting various substances to increase resistance, application of fertilizers, prolongation of dormancy, and the instigation of parthenocarpy) to direct attempts to maintain bud temperatures above the danger point by spraying continuously with water, by irrigation, infra-red rays, wind machines (blowers), central heating, soil heating, orchard heating and the reduction of radiation by smoke screens and chemical mists.

Although it would be extremely useful to have exact knowledge of the temperatures fatal to blossom and the environmental conditions likely to lead to these temperatures, apparently it is impossible to indicate any definite temperature that is universally fatal to fruit blossom in general or in particular to apple blossom. Not only is there a difference

of opinion between workers in different parts of the world, but also a difference in the behaviour of varieties. Varieties have been shown to vary in their degree of tolerance, and even in a single variety the critical temperature is found to vary with the stage of development of the blossom. In this country, however, it seems fairly safe to say that serious frost injury occurs when the air temperature falls below 28 ° F.

Much has been written about the movement of cold air on cloudless and windless nights (the so-called katabatic wind formed in a radiation frost) ; it is unnecessary to deal with that subject here. Very little, however, is as yet known about wind-frosts, but they occur less frequently than radiation frosts. It is noteworthy that fruitgrowers may produce local conditions conducive to frost injury. For example Rogers at East Malling has shown that the customary strawing of strawberries has the effect of insulating the blossom from the soil warmth. If done early, while spring frosts are still a risk, this practice may result in injury to the blossom and loss of crop. The difference in temperature above straw and above bare soil may be as much as 7° F.

Of the indirect methods of frost-injury prevention, plant-breeding, though offering hope for the future, can contribute little of immediate value. So far mineral fertilizers have been little tried but the fact has been established that a low level of soil nitrogen, by restricting the supply to the plant, retards blossoming by a few days and in certain seasons may assist blossom to escape frost. Recently it has been shown at East Malling that the renewal system of pruning results in a longer period of blossoming, which may improve the chance of some blossoms escaping frost injury. It is possible that a deficiency of trace elements, such as iron, may increase frost susceptibility. Induced parthenocarpy is now a well recognized possibility. Seedless pears were produced in the Ukraine in 1938 by treating the flowers with indole-acetic acid ; since then the production of seedless tomatoes with β-naphthoxyacetic acid has passed from the research stage to the hands of the grower. As yet only partial success has been recorded in this country (Long Ashton) in the production of seedless apples and pears, but it seems possible that further work will reveal the appropriate growth substance and required dosage to achieve complete success.

Some of the direct methods of maintaining buds at safe temperatures are impractical on a large scale, e.g., spraying with water continuously during a frost and irrigation immediately before a frost. Other methods that are being tried by fruitgrowers and research workers in this country are more hopeful. Thus the fact that there is often a layer of warmer air above the cold air in the orchard has interested experimenters, and various wind machines and blowers have been devised for the purpose of mixing the two layers together. Results have varied, though two years ago the successful use of a large (12 ft. and 21 ft. diameter) horizontal propeller was reported by workers in Australia (Shaw, R. A. & Redlich; F. *Rep. Coun. Sci. industr. Res. Aust., Div. Aeronautics, A.*, **56** (1946), 18). A similar propeller is now being tested in England in collaboration with the Institute of Agricultural Engineering.

Of all the methods tried, orchard heating by means of many small heaters has proved most generally successful. Where conditions are

suitable, and sufficient heaters, i.e., rather more than 100 per acre, can economically be used (by reason of cheapness of labour and fuel or high value of crop), this method provides a practical means of frost protection. In Britain both fuel and labour are costly, and usually it is considered that 50 heaters per acre are the maximum that can be afforded. Under ideal conditions these may maintain the air temperature some 4 °F. above that of the unheated area, but frequently this degree of protection is insufficient. Recently the possibility of warming the buds by infra-red radiation has further been investigated, and reports from Michigan claim good results from the use of infra-red, oil-burning radiators (Hassler, Hansen, C. L., & Farrall, A. W. *Quart. Bull. Mich. Agric. Exp. Stat.*, **30** (1947), 21-28). This method is thought likely to be practical with high-value crops subject to damage from low temperatures of short duration. Some preliminary trials are being made in Britain on the use of electric or oil-burning equipment.

Work on frost protection is in progress all over the world. A recent New Zealand publication described a frost research station that has been established adjoining the research station at Earnscleugh, near Alexandra, Central Otago, to investigate all aspects of the problem. At Wädenswil, Switzerland, extensive research is in progress, and a recent paper by Osterwalder (*Landw. Jb. Schweiz*, **61** (1947), 443-485), shows that critical temperatures have been determined for many plants. It is considered that rapid thawing can cause damage if the plant has already been cooled to near its critical temperature. If, however, a plant has been already damaged, or has not been cooled to near the critical temperature, the rate of thawing is of no significance. The formation of hoar frost is very important because when it is thawed by the sun, heat is absorbed and the temperature of the plant sinks, possibly below the critical temperature. This author agrees with the theory of Sorauer and Mez that plants suffer injury from cold when the temperature sinks below their minimum requirements and he does not agree with Müller-Thurgau and Molisch who consider that injury is due to loss of water from the cells by ice-formation. What is possibly another aspect of the former theory is advanced by Plutarco of Ecuador, who suggests that injury results from the coagulation of certain colloids in the protoplasm when they reach the isoelectric point. This may be brought about by a change in pH due to the accumulation of acids concerned with respiration which would be disposed of by normal metabolism at less cold temperatures.

In England, where frost research is co-ordinated by the Agricultural Research Council, the problem of orchard heating is being investigated by two members of staff of the Fuel Research Station, Greenwich (Mr. C. Baker, Physicist, and Mr. C. P. Sayles, Engineer), who have a mobile laboratory so that work can proceed away from headquarters. In the spring of 1947, before concentrating on developing their own ideas, they made a study of heaters and air circulators in use by growers.

The work of the Institute of Agricultural Engineering includes the study of equipment for frost prevention.

The reaction of the fruit plant to low temperature is being studied at East Malling Research Station, where one of the existing gas storage chambers has been altered to provide two small rooms for the investiga-

tions. One room can be used for very low temperatures, such as are experienced in severe winters, and the other for providing very accurate temperature control at levels of temperature common in spring frosts. The work will include investigation of the basic principles of frost injury and of all the factors that may affect the susceptibility and resistance of various fruit plants.

At Long Ashton further work is in progress on the use of growth substances to induce the production of seedless fruit.

The breeding of frost resistant apple varieties has been begun at the John Innes Horticultural Institution and at East Malling.

H.B.S.M.

GLASSHOUSE CROPS

Relative Effects of Sulphate and Muriate of Potash on the Tomato. *Ann. Report* (*32nd year*), 1946. *Experimental and Research Station, Cheshunt.*

This experiment, begun in 1939, was discontinued in 1946. The 1946 trials were made with the varieties *Potentate*, *E.S.*1 and *E.S.*5, the average tonnage per acre being 58.04 with sulphate of potash, and 53.94 with muriate of potash. There was a substantially higher percentage of blotchy ripening on the variety *Potentate* than on the other varieties, under both manurial treatments, but the muriate treated plots produced a slightly higher proportion of blotchy fruits than the sulphate. Of the two varieties *E.S.*1 and *Potentate*, *E.S.*1 tolerated chloride of potash (" muriate ") more than *Potentate*. In fact the quantity applied had practically no effect on *E.S.*1.

The conclusion drawn from the experiments is that under conditions at the experimental station, sulphate of potash can be replaced by muriate in times of necessity, but where the soil contains a higher proportion of chlorides than at Cheshunt, muriate of potash may be injurious.

Azobenzene as a Control for Red Spider Mite. Read, W. H. *Ann. Report* (*32nd year*), 1946, *Experimental and Research Station, Cheshunt.*

The methods by which azo-benzene is used in controlling red spider mites mainly on glasshouse flower crops in the United States, are described. Azobenzene is an orange red crystalline solid which vaporizes very slowly at ordinary temperatures. It is insoluble in water, but very soluble in many organic liquids. Azobenzene is a substance which has been little employed in industry and supplies of technically pure azobenzene were unobtainable. This necessitated the purification of crude azobenzene in the laboratory, and purified azobenzene is being used in laboratory investigations. There is no evidence that azobenzene is toxic to man, provided that prolonged exposure to the vapour is avoided ; solutions of the chemical in organic solvents, which may be used when fumigating by spray-vaporization methods, should not remain in contact with the skin, but be washed off with soap and water.

Experiments at Cheshunt are described in which tomato and carnation plants infested with red spider mite were subjected to azobenzene : (*a*) by vaporization by heat, and (*b*) spraying a solution of the chemical in a volatile solvent into the air of the glasshouse. The latter system is referred to as " spray vaporization," but it is also known as the " aerosol " system. The object is to obtain the necessary concentration of azobenzene vapour by the vaporization of the minute particles of azobenzene resulting from the evaporation of the solvent. In these experiments the azobenzene solution is discharged from a standard paint spray gun operating with compressed air. The air pressure employed was 45 lb. per square inch, and the rate of discharge adjusted to 3 fluid oz. per minute. Care was necessary with this method in tomato houses to prevent the mist from the gun coming into direct contact with the plants, as this caused injury, and the rate of discharge had to be regulated to avoid this. Acetone was used as the solvent in most of the trials, both 20 per cent. w/v and 12.5 per cent w/v solutions of azobenzene being discharged at the equivalent of 0.3 oz. azobenzene per 1,000 cu. ft., without injury to tomatoes or carnations. Experiments made when conditions enabled a temperature of 70° F. to be maintained for 6 hours after treatment, gave kills of 85 per cent. of the adult females, and 100 per cent. adult males. Azobenzene appears to act on the embryonic tissues of the mites, and effectively kills all the young stages, and destroys the eggs. There is a risk, however, of treated adult females laying viable eggs before they succumb.

Many glasshouse trials have been made since the publication of this paper, including the use of azobenzene in " smoke " form, and the results of these trials will be dealt with in a future issue. Azobenzene smoke generators are now on the market, and information to date indicates that their control of red spider mite is equal to that by the spray-vaporization method.

E.S.

FLOWERS

Prepackaging of Cut Flowers. Hauge, A., *Proc. Amer. Soc. Hort. Sci.* **49**, 427-432

Cool storage of flowers, either on the nursery or during transit, is widely practised in America. This paper describes experiments on " prepackaging " of roses, carnations and pompon chrysanthemums before placing in cool store.

Flower boxes (? cardboard) were coated inside and out with paraffin wax to lessen absorption of moisture from the enclosed atmosphere. Cut flowers, with or without previous treatment in water, were then placed in the containers and enclosed in a gas-impervious cellophane bag and sealed with a hot iron. Mechanical packaging machines can be used on a large scale. The packages were then stored for 7-8 days at 40-45° F., opened, and the flowers stood in water at (American) air temperature, 70-75° F.

Carnations gave the best results with direct packaging after cutting without previous standing in water, lasting 2 or 3 days longer than controls stood in water at the same temperatures. Roses, either packaged direct

or after standing in water at 40-45° F. for up to 10 hours also gave good results. Chrysanthemums showed little advantage in the method over cool storage with the stems in water (but might travel much better compared with flowers in " open " boxes).

A New Method of Hyacinth Propagation, Involving Additional Wounding, the Use of Fungicidal Dusts, and a Growth-promoting Substance. Bosher, J. E. and Newton, W. *Sci. Agric.*, **28** (1948), 26-27.

The mother bulbs are cut around the basal plate to a depth of three or four scales. The severed scales are then removed and are cut longitudinally into sections approximately one inch in width at the base. The sections are then treated with a fungicidal dust and kept in moist peat or peat and sand in an incubator or propagating frame for three months at a temperature of 78-80° F. Small bulblets form freely on the sections and are separated by screening the whole through a $\frac{1}{4}$ in. sieve. Of the fungicidal dusts used Spergon and Arasan proved the most effective. The addition of 1 ml. of a solution of naphthalene-acetic acid containing 100 p.p.m. to 5 gm. of the dust considerably increased bulblet formation.

The residual cores bearing the basal bud are similarly treated with the dust and replanted under field conditions, when they usually produce bulbs as large as the originals in a single season. This is claimed as a great advantage in propagating new or rare varieties as the risk of losing the original bulb is removed.

The Control of Penicillium spp. on Tulip and Iris Bulbs in Storage by Fungicidal Dusts. Bosher, E. J. and Newton, W. *Sci. Agric.*, **28** (1948), 47-48.

Penicillium mould on bulbs in store can cause considerable losses. Growers frequently dust bulbs with flowers of sulphur as a control measure. This paper is an account of studies on the effect of a number of proprietary (American) fungicidal dusts and also of sulphur in controlling the mould. Of the dusts used, Spergon, Arasan, Dow No. 5 and Nomersan were all effective, while Fermate, Dithane, and a proprietary Bordeaux dust were ineffective. The interesting point to British growers is that flowers of sulphur was of no value at all as a control.

2,4–D Treatment for the Control of Weeds in Plantings of Gladioli. Throne, P. R. and Hamner, C. L., *Proc. Amer. Soc. Hort. Sci.*, **49** (1947), 370-378.

The two " plant-hormone " selective weed-killers, 2,4–dichloro-phenoxyacetic acid and 2-methyl-4-chloro-phenoxyacetic acid (" Methoxone ") are achieving wide popularity for weed-control on a field scale. This paper describes experiments on the use of the former either added to the soil before planting or applied as a spray to the growing crop.

Spraying of the soil with a solution of 2,4–D at the rate of 10 or 20 lb. per acre three weeks before planting gave promising results. Earlier planting after application resulted in damage. Spraying the growing crop caused damage in all the trials made. R.H.S.

MYCOLOGY

Onion White Rot. (*Sclerotium cepivorum*)

This disease appears to some extent every year, and apart from avoiding the growing of onions on contaminated land there has been little that could be recommended by way of control measures. Recently, however, Booer has obtained promising results by treating the soil with calomel. The best effects were obtained when 4 per cent. calomel dust was applied to the open seed drill at sowing time. One pound per 50 yards of drill was sufficient for spring sown salad onions but a better control was obtained in a bulb onion crop when the rate was increased to 1 lb. per 25 yards of row. Broadcasting the dust at the rate of 3 cwt. per acre before sowing also gave promising results, though it was not as effective as applying dust in the drill. Experiments with autumn-sown onions were not so satisfactory as although a good control of the disease was obtained the treatment appeared seriously to retard the growth of the onions causing reduced yields.

Experiments on the control of White Rot in Onions. Booer, J. R. *Ann. App. Biol.*, **32** (1945), 210-213.

Further experiments on the control of White Rot in Onions, Shallots and Leeks. Booer, J. R. *Ann. App. Biol.*, **33** (1946), 413-419.

Control for White Rot disease of Onions. Booer, J. R. *The Grower*, **27** (1947), 544.

Onion Smut

The result of the 1943 survey reported by Moore indicated that this disease is much more widespread though less harmful than has been previously thought. Consequently the Onion Smut Order of 1921 was revoked the following year. However, serious attacks occur from time to time and less serious ones are probably frequent as thinning out of the seedlings through this cause is often not noticed by the grower, especially as in some cases the typical smut balls form just at or below ground level. The most effective control measure still appears to be protection of the seedlings by the use of formaldehyde solution applied when the seed is drilled, as is described in Advisory Leaflet No. 261. Interest has, however, been aroused by the method tried in the United States in which the onion seed is coated with a fungicide before drilling. The treatment usually consists of first shaking the seed with sticker and then adding a fungicide and shaking again until all the fungicide adheres to the seed. The seed is then dried quickly before drilling. Although this treatment has not always been as effective as formaldehyde, especially in cases where the soil is heavily contaminated with the fungus, it has given useful results under some conditions. In trials on a limited scale in England a good commercial control of the disease was obtained by the use of two dusts, one containing ferric dimethyl-dithio-carbamate and the other tetramethylthiuram disulphide. The dusts were used at the rate of 1 lb. of dust to 1 lb. of seed and a resin potash sticker was used to obtain good adherence. Full details of these experiments will be published shortly.

Studies on the control of Onion Smut by seed treatment in Oregon. Miller, P. W. and McWherten, F. P. *Rev. app. Mycol.*, **24** (1945), 305.

Diseases of Crop Plants, 1943-46. Moore, W. C. *Ministry of Agriculture Bulletin* **139**, *H.M.S.O.* 1948.

Dust fungicides versus formaldehyde in the control of Onion Smut. Nelson, R. *Rev. app. Mycol.*, **26** (1947), 436.

Pelleting of onion seed with fungicides. Newhall. *Farm Research.* **11** (1945).

Studies in vegetable treatments in 1943. Newhall. Plant Disease Report Supplement 145, 1944. *Rev. app. Mycol.* **23** (1944), 507-508.

Downy Mildew

This is probably the most widespread of all onion diseases in this country and so far all attempts to control it with fungicide have been disappointing. One of the big difficulties is to find a suitable fungicide which will adhere to the onion foliage. Hickman, Marsh and Wilkinson appeared to have solved this problem by using an oil soluble fungicide which was atomized on to onion foliage. Unfortunately no control of onion Downy Mildew was obtained possibly owing to too few applications. Moore has reported results of trials carried out in 1943 and 1944 in the South West by E. C. Large. In these experiments some protection of the foliage was obtained by six fortnightly applications of Bordeaux mixture, but in 1943 there was only a little, and in 1944 no significant increase in yield. In 1944 lime sulphur and green sulphur had no protective effect.

Preliminary experiments on the use of oil-soluble copper fungicides. Hickman, Marsh and Wilkinson. *Ann. app. Biol.* **30**, (1943), 179-183.

Diseases of Crop Plants 1943-1946. Moore, W. C. *Ministry of Agriculture Bulletin* **139**. *H.M.S.O.* 1947.

Neck Rot

Neck Rot caused by various species of *Botrytis* is troublesome most years in stored onion bulbs. In the last few years a little more information has become available. Wallace and Hickman found that early lifting caused a reduction in the loss during storage, but in one of their two trials this saving did not compensate the reduced weight obtained by lifting early and in no case was the loss negligible. In the following season Croxall also found that the loss in storage from early lifted bulbs was significantly less than in bulbs on which the tops had completely died down. In these experiments dusting the bulbs at lifting with sulphur and two proprietary organic fungicides had no effect on the subsequent losses.

Some factors influencing loss of onion bulbs in storage. Croxall, H. E. *Ann. Report, Long Ashton Research Station*, 1945, 143-147.

The influence of date of lifting and method of storing on loss of onion bulbs harvested in 1943. Hickman, C. J. and Wallace, E. R. *Ann. app. Biol.*, **32** (1945), 200-205.

Shanking

Shanking, a comparatively new disease of onions, was first recognised and described by Hickman in 1943. The symptoms of this disease are yellowing and shrivelling of the leaves and softening of the base of the plant which later extends to the bulb itself. The symptoms are very similar to those of shanking of tulips and are also caused by species of *Phytophthora*. It is probable that this disease may be fairly widely distributed although so far few serious outbreaks have been seen.

Shanking of Onion and Shallot associated with species of Phytophthora. Hickman, C. J. *Ann. Report, Long Ashton Research Station*, 1943, 100-102.

H.E.C.

ENTOMOLOGY

Wireworm Population Studies

The paper on this work by G. F. Cockhill, D. M. Ross and J. H. Stapley has been published in four parts; parts III and IV are of especial practical interest.

Part III. Population Changes after Summer Ploughing. *Ann. app. Biol.*, **34** (1947), 83-96.

Information was obtained by fortnightly samplings of six permanent pastures broken during the summer of 1943. It was found that a marked fall in the population of wireworms occurred only after the first crop had been harvested. The results show that the wireworm population is not affected until the following spring and summer during the cropping period, but comparison with the unbroken pasture shows that the population decline in spring and summer is not more marked than that which normally takes place at this time in grass fields. The result of the breaking of the pasture is, however, to make the reduction a permanent one.

Part IV. Population Changes during a Bare Fallow. *Ibid*, 95-103.

These studies took place on twenty-three fields subjected to bare fallow, during 1943 and 1944. In every case wireworm populations were much reduced, sometimes by as much as 90 per cent., small wireworms being practically eliminated. The practical value of the work has been to show that the greatest reduction of the wireworm population by means of a fallow will take place if the grassland is ploughed in February or March. The opinion is given that failures of the first and second year crops might have been largely avoided if a full fallow had been taken in the first season, and that the gain in this way would have compensated for the missing of a hay crop before the land was broken.

Slug Damage to Potatoes. Thomas, D. C. Some observations on Damage to Potatoes by Slugs. *Ann. app. Biol.*, **34** (1947), 2, 246-251.

Observations have shown that it is the Garden slug, *Arion hortensis*, Fer, and the Keeled slugs, *Milax* spp., which are mainly responsible for primary damage to potato tubers in the south west. A variety trial clearly demonstrated that, of three varieties tested, Arran Banner was most damaged and Arran Peak the least; Majestic was in an inter-

mediate position. These varietal differences in the time and amount of damage were found to be associated with differences in the dates of maturity. Little damage occurred prior to the maturing of the tuber. The practical outcome of this work is an emphasis on the need for prompt lifting of the crop as soon as it is mature. In this way slug damage may largely be avoided.

Gout Fly attacks on Wheat. Lilly, A. H. R. Investigations on the Gout Fly (Chlorops sumilionis, Bjerk.) in Devon and Cornwall. *Ann. app. Biol.*, **34** (1947), 4, 551-561.

Field observations were carried out from 1943-1946 on attacks by Gout Fly on wheat in south-west England, and these showed that there are two generations of the fly during the year, the first emerging in May from eggs laid the previous October, and the second emerging in late July and early August. The first generation is responsible for damage to spring wheat and may also attack any very late sown or backward autumn wheat; any wheat not above ground before 20th October escapes attack by the second generation. It has been found by observations and experiments that the optimum period for drilling wheat to escape Gout Fly damage is mid-October. In the south-west both generations of the fly show a marked preference for wheat, attacks on barley being negligible.

Control of Pea Moth. Wright, D. W. and Geering, B. A., *Agriculture*, **54** (1947), 124-129.

This article gives useful information on the effects of early sowing in reducing the level of infestation where early maturing varieties of peas are concerned. It is reported that varieties providing dense foliage cover are found to be more susceptible than sparser crops. From the experiments carried out on the variety *Onward*, the following recommendations are given :—

Where crops are to be picked green, an application of a DDT emulsion spray, at a strength of $\frac{1}{2}$ per cent., at about 7-10 days after the first flowers appear, i.e., just before the eggs hatch. Where the crops are to be harvested as dried peas, the number of applications should be increased to two; the first as for the crops picked green, but followed by another application 14 days later. Each application requires 140 gal. per acre of diluted spray.

Use of Selenium in the Control of Eelworms. Fraser, L. *Journal Australian Institute of Agricultural Science*, **13** (1947), 1/2, 67-68.

Established chrysanthemum cuttings infected with the leaf eelworm (*Aphelenchoides ritzema-bosi*) while growing in pots were watered with 0.25 per cent. solution of sodium selenate to give a concentration of 25 p.p.m. in the dry soil. The solution was found to be toxic to the plants and caused small circular dead spots on the leaves; subsequent growth was normal. Eelworm failed to develop in any of the treated plants, which were also not attacked by leaf-hoppers, caterpillars or aphis during the succeeding months. Untreated plants were attacked by all the pests and also developed moderate to severe symptoms of eelworm attack.

Dimock, A. W. *Phytopathology*, **34** (12), 999.

This paper deals also with the use of sodium selenate on chrysanthemums and records similar results. Two doses of the chemical gave complete control, but damage to plants ; one dose gave only slight damage, but control was not complete.

L.N.S.

INSECTICIDES AND FUNGICIDES

Wartime research on pest control was so fruitful that the application of this work to agriculture is now producing numerous and various successes. To mention all would reduce these notes to a mere catalogue, but one or two items of immediate interest will be described in each issue.

Hexaethyl tetraphosphate (HETP)

The probability that nicotine will be scarce has accelerated the development of hexaethyl tetraphosphate which, during the war, was used in Germany as a nicotine substitute. It is a light-brown liquid, soluble in water and, at a concentration of 0.06 per cent. (slightly higher than that generally used for nicotine, i.e., 0.05 per cent. or 8 oz./100 gal.), is highly toxic to greenfly. Judging from first trials, it is even better than nicotine against the mealy aphids, but it has not yet been possible to confirm claims of effectiveness against acarids such as fruit tree red spider.

Like nicotine it is highly poisonous to man and livestock, yet there is no danger from poisonous spray residues. Nicotine is rapidly lost by evaporation from the spray residue ; HETP, on the other hand, is decomposed by water to non-poisonous compounds, Consequently when once diluted with water, HETP must be applied as soon as possible and, if the spray is left overnight, it will have lost much of its insecticidal potency. As this decomposition is hastened by alkali, HETP cannot be used with other spray materials of an alkaline reaction such as lime sulphur or lime-containing products. For the same reason soaps cannot be used to facilitate the wetting of HETP sprays ; the wetting agent, and one should be used, should be specially chosen from the alkali-free wetters. Of those given in the Dec. 1947 List of Approved Products issued by the Ministry, L 164, 233 and 234 are suitable. Alternatively a compounded product containing HETP already mixed in the correct proportions with a suitable wetter may be used.

Incompatibility with lime is perhaps the most serious practical limitation of HETP, but at least it prevents its addition to the post-blossom lime sulphur sprays for the purpose of controlling apple sawfly. It is doubtful whether the phosphate would control this pest as effectively as nicotine even if applied apart from the lime sulphur, for nicotine does not have a straightforward contact action against the newly-emerged sawfly larva.

HETP provides a puzzle to the chemist for although its ulitmate analysis agrees with the structure implied by its name, its behaviour

in other respects is that of a mixture. Yet samples prepared by different methods have given identical results as insecticides and have had similar rates of decomposition in aqueous solution (Bennett and Martin, *Ann. report Long Ashton Research Station*, 1947, p. 147). On distillation at low pressures, however, a fraction agreeing in composition to tetraethyl pyrophosphate (TEPP) is obtained, and this compound has been found to be several times as toxic to aphides as HETP (see Ludvik and Decker, *Jour. econ. Ent.*, **40** (1947), 97 ; Zimmerman and Hartzell, *Contr. Boyce Thompson Inst.*, **15** (1947), 11). It is likely that TEPP will be developed commercially as a competitor to HETP, but the reasons why it was not so used in Germany where its insecticidal properties were known (Schrader, *Brit. Intell. Obj. Sub-Comm. Final Report*, 714 (1947) are obscure.

So far no report of spray damage at insecticidal strengths by either compound has appeared but one point to note is that both compounds corrode black steel and tin plate. Consequently products based on either should not be transferred from their original container. Their poisonous properties should be stressed, but soap and water effectively removes danger, though respirators would be necessary if attempts are made to use them as aerosols.

Sodium selenate

The observation (Hurd-Karrer and Poos, *Science*, **84** (1936), 252), that wheat growing on the seleniferous soils of the Middle West remained free from insect attack lead to successful trials of sodium selenate in pest control, dilute solutions being used to water the plants which thereby became resistant to insects. But the use of selenate should be confined to non-food plants, for the treated plants become poisonous to man and to stock. The recent publication in this country of particulars of the sodium selenate method of controlling the chrysanthemum eelworm has raised enquiries of the nature and degree of the risks run in adopting this method. The risk is aggravated by the permanence of the selenium in the treated soil and plants, and by its insidious poisonous properties, which are illustrated by the following experiments made recently at Long Ashton (Bennett and Martin, *ibid*). Grain weevils were placed in wheat either directly treated with sodium selenate solution or harvested from plants watered at flowering with the solution. At the end of four weeks the weevils appeared to be unaffected and were removed. The wheat was stored a further four weeks and the infestation in untreated wheat built up normally, but the selenium-treated wheat remained free from attack. The selenium treatment had not killed the weevils but it had prevented their reproduction. A similar effect of selenium poisoning has been noted in warm-blooded animals, but with livestock is usually preceded by a loss of hair, hoof, and horn and a general unthriftiness—the so-called alkali disease—symptoms of which might be overlooked in man. Being aware of this danger of selenium poisoning, who would care to recommend the treatment for use even on non-food crop plants ? Clearly before selenium treatment is to be used at all, fool-proof methods of removing all selenium from the treated soil must be discovered.

H.M.

SOILS

Phosphate Fixation in Soils. Williams, E. G. *Scottish J. Agric.*, **24** (1943).

Phosphates applied to soil have little mobility and remain essentially in the area of application. In cultivated soils there is little penetration beyond the cultivated layer, whilst in grassland penetration seldom extends more than two inches. This is due mainly to phosphate fixation, a condition which prevents full use being made of phosphatic fertilizers by decreasing availability and prevention of penetration to areas where plants can make full use of them.

Fixation takes place in two main ways—" biological " and " chemical." In biological fixation bacteria convert mineral phosphates into organic forms which are useless to the plant. Chemical fixation, the more important type, takes place through interaction of soil minerals in two main ways—" absorption " and " precipitation."

Absorption occurs through the abstraction of soluble phosphates by insoluble iron and aluminium compounds as well as by certain silicate minerals. This type of fixation predominates in heavy soils and is greatest under acid conditions. Phosphate so fixed is unavailable, and slowly undergoes further change to give totally insoluble iron and aluminium phosphates. Because of absorption reserves of soil phosphate must be built up before any benefit results from application of phosphatic fertilizers.

Precipitation, differing from absorption, results from the interaction of soluble iron, aluminium, calcium and magnesium compounds with water soluble phosphate. The value of the precipitate to the plant, and also the form it takes, depend on soil conditions. In acid soils, mainly, iron and aluminium phosphate are precipitated. Freshly precipitated, these compounds can be utilized by the plant, but they are quickly converted into insoluble compounds in which the phosphate is inert. In slightly acid or neutral soils, mainly calcium phosphates are precipitated. These compounds are the most available of all fixed phosphates in the soil. In alkaline soils, calcium phosphate, in the form of apatite, is formed. This compound is useless as such to the plant.

Control of phosphate fixation can be effected by (*a*) liming acid soils (*b*) using suitable forms of phosphatic fertilizer in the most efficient manner. There is little to choose between basic slag and superphosphate, but reverted phosphates, especially those prepared by using dolomite and serpentine, are stated to be superior to superphosphates. Mineral phosphates and bone meals are more effective in acid soils. When applied in granular form, phosphate fertilizers are less readily fixed than when finely ground. A similar condition results when the fertilizers are placed—a concentrated layer as opposed to broadcasting.

J.W.B.
W.M.D.

The Nitrogen and Mineral Content of the Produce of Grassland. Fagan, T. W. and Davies, R. O. *Report of the Fourth International Grassland Conference, Aberystwyth*, 1937, 370-376.

The pastures of Mid-Wales are situated on soils of low phosphate and lime content, but adequately supplied with nitrogen and potash. Chemical composition of the herbage varies according to the botanical composition.

For investigational purposes, individual varieties of grasses and clovers were grown in plots under typical lowland conditions. Chemical analysis of herbage cut at monthly intervals showed that nitrogen and mineral composition varied slightly but significantly between individual species of grasses and clovers as well as between strains of those species.

Taking perennial ryegrass and cocksfoot (which are fairly high in nitrogen, lime and phosphoric acid) as standards, then by comparison meadow foxtail is higher in nitrogen but lower in lime and phosphoric acid ; tall oat is higher in phosphoric acid but lower in nitrogen and lime, and red fescue is higher in lime but poorer in nitrogen and phosphoric acid. Clovers have a nitrogen and lime content almost double that of any species of grass but the phosphoric acid content is lower than most. Consequently, the proportion of clover in a mixed herbage has a pronounced effect on the nitrogen and mineral content.

An important factor in the chemical composition of grasses is the ratio of leaf to stem. Leaves have a far higher nitrogen and mineral content than the stems at all stages of growth. During the growing season the ratio of leaf to stem first decreases and then increases but the nitrogen and mineral content decreases. At maturity, the nitrogen and phosphoric acid content of leaf and stem falls to approximately one third of its value when immature ; the lime content of the leaf increases and that of the stem decreases.

In comparing the chemical composition of natural agrostis and nardus upland pastures with lowland pastures the former are found to have a lower nitrogen, lime and phosphoric acid content. Increases in these constituents could be made by suitable manuring and management. Manuring alone caused a slight improvement ; manuring and cultivations made a substantial improvement ; and manuring, cultivations and seeding raised the nitrogen and mineral content to that of lowland pastures. Liming was a primary factor, and whereas the effect of lime was exhausted on the agrostis type of pasture in about five years, it persisted in the nardus type.

J.W.B.
W.M.D.

The Composition and Manurial Value of Sewage Sludges.

Emp. J. exp. Agr., **7** (1939), *Inst. of Sewage Purification*, Papers read at Annual Meeting London, 1942, and Birmingham, 1944, *Agriculture*, **52** (1945), 3.

The increasing shortage of organic manures caused by the diminishing quantity of dung available for sale off the farm, has raised in recent years the question of the value of sewage sludge particularly for market garden and intensively grown farm crops. A series of experiments carried out on sand land in Nottinghamshire in 1935-37 by H. T. Cranfield, in which domestic sewage sludge was compared with farmyard

manure for potatoes, clearly demonstrated that this material, when supplemented by fertilizers, had a definite value as an organic manure. The availability of its plant nutrients and general effect on the crop was, however, somewhat lower than that of an equal weight of dung, probably of the order of 50-75 per cent.

This question was taken up early in the war period by E. M. Crowther and A. H. Bunting of Rothamsted, and after discussion with the managers of sewage disposal works (represented by the Institute of Sewage Purification), numerous pot experiments and field trials were planned and carried out over a period of several years. In addition a large number of analyses of sludges were made to ascertain their variability as regards plant nutrients in relation to methods of production.

Nitrogen is the important nutrient in sewage sludge, but is not as available as that found in dung. Much of it is in an inert form which breaks down very slowly. Phosphate content varies considerably and here again its availability may be very low. Potash content is often negligible owing to the fact that the bulk of the potash in the crude sewage is lost in the effluent from the drainage beds. This means, therefore, that as regards the three main plant nutrients sewage sludge is not as valuable a manure as dung. As an organic supplement, sludge differs markedly from dung in that a large proportion of the organic constituents is in a colloidal form, which gives to sludge its sticky character. Although suitable for light land, sludge would not have the " opening-up " effect of dung on heavier soils.

Some ten types of sludge were used in the experiments, and results indicated that the nitrogen content in particular, and its availability, varied considerably with the method of treatment at the works. Activated sludge, undoubtedly, has the highest nitrogen content of any sludge, but this material is very difficult to de-water and economic drying is at present an unsolved problem. With industrial sludges there is always the possibility of toxic substances—chromium, nickel, etc.—being present.

In Crowther and Bunting's second paper, experiments are described in which industrial and domestic sludges were compared, but the results varied considerably. With potatoes, the industrial sludge gave poor results but moderate responses were obtained from the domestic type, though even these were not as good as those resulting from the application of dung. However, it is obvious from the results of these experiments that much more detailed investigation is required before the real value of sewage sludge as a manure can be assessed. The great variability in physical and chemical composition makes the whole question very complicated.

A possible use of sludge in composting straw is referred to by Bunting (*Agriculture*). Preliminary experiments in 1944 showed that a useful compost could be made under suitable conditions and trials with the material gave encouraging possibilities. Much more experimental work, however, was indicated particularly as to the use of liquid sewage and straw instead of sludge and straw.

H.T.C.
W.M.D.

MACHINERY

Machinery for Fodder Conservation

Grass Drying.—The value to the farmer and to the nation of the grass drying process is still a controversial subject, and it is difficult at present to obtain a properly balanced view of the ultimate potentialities of the process as a farm scale method of conservation. It is worth noting, however, that the most ardent advocates include some capable farmers who have themselves been using the artificial drying process for a number of years. Recent papers on the subject read before the Institution of British Agricultural Engineers were both by farmers. The first paper, entitled *Grass Drying Plants* by C. B. Chartres, deals mainly with types of driers and factors affecting design. Practically all British driers operate with long grass and employ trays or band conveyors. Hot gas temperatures must not exceed 350° F. Some Continental and American driers, however, dry chopped material and carry out the drying in two or more stages. High temperatures, e.g., 1,000 ° F. to 2,000 ° F., are used in the first stage, and particles pass to the second lower temperature stage before they become overheated. A description of British and Continental driers and a table showing comparative performances are included.

The second paper, by W. Newcombe-Baker, deals with various practical and economic aspects of grass and lucerne drying in Norfolk. Interesting points include Mr. Newcombe-Baker's dislike of ryegrass and red clover mixtures for drying, and his conclusion that field wilting is not worth while in his district (a view not shared by some other operators). There is some discussion on the economy of having a dual-purpose grass and grain drier, and on the layout of such plants. Details of organization and labour are given, and the percentage drying costs on his farm are made up as follows :

> Wages 22, Fuel Oil 21, Electricity 10, Overheads 20, Depreciation 13, Sacks, etc., 14.

The results of the M.M.B.'s first year of co-operative drying at Thornbury (*Agriculture*, **54** (1947), 392) have caused much discussion. The most striking testimony in favour of grass drying comes from the few farmers who have used the process merely for the purpose of feeding their own stock. One such is Mr. T. S. Bennett, and his statements (*Farmers Weekly*, 23.1.48, p. 27) (*Farm Mechanization*, Jan.-Feb. 1948, p. 5) are worth study.

Dr. R. E. Slade, in a paper to the Farmers' Club (*Journal Farmers' Club*, 1947, **8**, 105) presented an analysis of the position of grass drying in relation to other methods of fodder conservation. Figures for drying cost on his farm in Hertfordshire are given as £7 to £12 a ton, excluding the cost of the crop and carrying it to the drier. Total production cost for the 1947 season was estimated at around £18 a ton.

Barn Hay Drying.—There is some interest in Britain in methods of hay finishing similar to the " Mow-Drying " which has received much attention in the United States in recent years. Experiments on the

process are proceeding at several centres in Britain, and it is still too early to form definite conclusions. Mr. P. Finn-Kelsey described preliminary work by the British Electrical and Allied Industries Research Association at a conference of the Tractor Users' Association in December, 1946. Those who are interested in the process should read a series of papers on American research published in *Agricultural Engineering* (Mar., April, May, Nov. and Dec., 1946 and Feb., Mar., May, June and July, 1947). These papers deal mainly with the engineering aspects of the subject, including details of design of motors, fans, ducts, and mows ; the flow of air through various sorts and conditions of hay, and equipment for handling partially dried hay. In some of the papers (e.g., Dec., 1946, p. 565) the important effects of respiration in the hay are dealt with, and in one or two of the papers (April, 1947, p. 154 ; June, 1947, p. 251) the process is compared with other methods of hay curing. The general impression gained from these papers is that even in the United States, where the climate is on the whole much more favourable for both field haymaking and mow-drying than that of Britain, the process is not yet permanently established, and silage making is likely to be a more efficient conservation process than barn curing. One of the difficulties seems to be that the process works well in good haymaking weather but is less effective when haymaking weather is unfavourable.

Messrs. C. A. Cameron Brown and P. Finn-Kelsey have recently prepared a detailed report (*Tech. Rep. W/T17 of the E.R.A.*) of the British experiments which, when published shortly, will make very interesting reading. They consider that the process can be economically employed, using unheated air ; and that when simplified handling methods have been developed this method of conservation will prove attractive on many small British farms.

Silage Making

Tractor Buck-Rakes.—Rear-mounted tractor sweeps, or buck-rakes, have been used in the United States for haymaking over a long period. Many of these devices are home made, and the lifting mechanism is frequently contrived out of the final drive and rear axle of a car or motor lorry. Details of construction and mounting are given in a number of Extension Service bulletins, including those published by the Dakota A.E.S. (*Circ.* 49), the Ohio State Univ. Agric. Extn. Service (*Bull*, 427), and the Ontario Dept. Agric.

The built-in hydraulic lift, now commonly provided on British all-purpose tractors, has now been fitted up to operate a small buck-rake with tubular steel tines for carrying silage.

The tractor with the buck-rake lowered backs along the line of a pair of swaths and collects small loads of silage. It then raises the load by means of the hydraulic lift and proceeds in its forward gears to empty (*Farm Mechanization*, Jan.-Feb., 1948). The possibilities of this method of picking up and carrying silage are immense, but a full assessment of its value for collecting grass on soft or uneven ground must await further field experience.

C.C.

PROVINCIAL NOTES

COLORADO BEETLE

W. E. H. Hodson
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It is essential that every N.A.A.S. officer should be thoroughly familiar with the Colorado Beetle situation in this country, and should realize to the full the importance and difficulties attached to the problem confronting us at the present time. These points need no stressing to officers in southern and eastern areas, but elsewhere, through lack of opportunity, the dangers of the present emergency are perhaps not adequately realized.

If the Colorado Beetle become firmly established in Britain, which may well happen this year, potato targets will be seriously affected and a real famine may confront us in the coming autumn and winter. Further, compulsory spraying may have to be introduced generally. The attendant difficulties of this alone, in the way of wholesale diversion of man-power spraying machinery, insecticides, inspection of crops, issuing of permits and so forth, need no enlarging upon.

In addition, taking a longer view, the outcome would inevitably be a considerable and permanent addition to the cost of production for potatoes. It is necessary only to look across the Channel to see these things happening, the result of permitting the beetle to get out of hand during the war years. In fact, so serious is the Continental position to-day, that an International Conference on the control of Colorado Beetle has been set up.

History of the Beetle

The beetle originated in Central America, feeding upon a wild plant, Buffalo Burr (*Solanum rostratum*). It changed to the cultivated potato for its food plant, probably some 80 years ago, and from that time onward, spread rapidly through North America, demonstrating as it went its ability to thrive under any conditions that the potato plant will tolerate.

In Britain, as far as we know, it occurred and bred first in 1901 at Tilbury, almost certainly arriving by ship from the New World. It was stamped out at the cost of much trouble and expense. Subsequently, from time to time, it made its appearance, and as often was successfully wiped out. All the time, however, possible sources of infection were drawing nearer to our shores, and as the beetle can fly at least 40 miles, the Channel is no bar to direct entry, even if beetles are not introduced by means of ships or aircraft.

In 1920, it obtained a foothold in France, near Bordeaux, since when it has invaded the whole of France, the Channel Islands and passed into Holland, Belgium, Germany, Luxemburg and Switzerland.

Real trouble (information was withheld at the time for security reasons) started in Britain in 1941. Potato crops were attacked in six places in S.W. England and S. Wales. In 1942, five outbreaks were

found, still in the S.W. ; in 1943, one only, in Wiltshire ; in 1944, none was found. In 1945, the scene of control activity moved eastward when ten attacks were detected, principally in Kent. In 1946, there were some 25 occurrences, again principally in the East, but also a number to the north of the Thames.

In 1947, no less than 264 occurrences were recorded, many being single beetles obviously imported on produce from the Continent. Breeding on potatoes was detected at 50 different places. Counties in which beetles bred were : Middlesex, Surrey, Sussex, Kent, Bucks., Beds., Herts., Norfolk, Suffolk, Somerset, Northants and Warwick. By far the greater number occurred in Kent, followed by Surrey.

Every known breeding place was systematically dealt with. To accomplish this, particularly in Kent and Surrey, N.A.A.S. personnel worked seven days a week for many weeks, solely on beetle control, all other work having to be abandoned entirely. About 10,000 acres of potatoes were sprayed or dusted as a precaution. Actual outbreaks were rigorously dealt with, spraying, dusting and/or visual inspection of all potato crops within a prescribed radius of outbreaks being carried out. Soil injection of carbon-bisulphide was carried out on the site of each outbreak, followed by periodic inspection for possible recurrences of beetles or larvae.

In addition, large acreages of potatoes in vicinities of previous outbreaks, in coastal areas and around airports were inspected. Some 60 temporary inspectors, recruited amongst University students, were employed on this work and were responsible for the timely detection of a number of new outbreaks.

For the year 1948 it is being assumed, for practical purposes, that the whole of an area bordered on the north by the Thames, and on the south by a line running roughly from Guildford (Surrey) to Hythe (Kent), is likely to be carrying an overwintering population of beetles. Accordingly, all potatoes in this area, amounting to some 23,000 acres are to be sprayed or dusted ; areas under 2 acres are to be inspected visually. Similar treatment will be accorded some 6,000 acres in the vicinity of 1947 outbreaks in the Eastern counties.

The above programme is clearly a large one, and to carry it out properly requires careful organization. It is based upon experiences obtained on a small scale in previous seasons, and is considered to be the minimum action which is likely to check further trouble in these areas.

At the same time, there is every possibility that outbreaks may occur in places far removed from the scenes of these control activities. It is of paramount importance that *every* outbreak be discovered immediately and efficiently dealt with. As indicated earlier, if this is not done, irremediable injury to potato crops and to the country as a whole will eventually be inevitable.

Note.—At the time of going to Press (late July) 7 small outbreaks, with beetles breeding, have been detected this year (6 in the S.E. Province, 1 in the W. Midland Province). In addition, some 300 individual beetles have been detected, the majority on ships arriving from Continental ports.

THE QUIZ AS AN AID TO ADVISORY WORK

R. Sayce
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In an effort to combine both education and entertainment for an agricultural audience the members of which have done a day's work, an organizer must have variety in a winter's programme. Ordinary lectures soon begin to pall, even if they are delivered in the best manner by the best people, whilst the range of agricultural films is soon exhausted, especially as there are so few good films.

During the war years the Brains Trust was introduced and soon became popular, in fact like Charley's Aunt, it is still running, but if the interest and attendances are going to be maintained fresh features must be introduced. The competitive spirit provides a means of fostering this interest, and therefore from the very outset the Agricultural Quiz proved to be and still is a favourite item in Agricultural Club programmes. From the organizer's point of view the Quiz has an advantage over the Brains Trust; the team is drawn from members of the Club, whereas usually a successful Brains Trust involves the bringing in of several outside speakers. Club members who are not happy serving on a Brains Trust are not so shy of taking part in the Quiz.

There are, perhaps, many people who are prepared to say that the Quiz is a stunt, or a poor copy of the B.B.C. programme, or of no educational value, but when badgered into their first Agricultural Quiz they usually admit that it is both entertaining and instructive. There are other people who may go simply for the opportunity of hearing one or more people on the platform making "asses" of themselves, or getting no marks for an incorrect answer, or giving no answer at all.

There is no doubt that the Brains Trust has retained its popularity because information on certain subjects, whether spontaneous or not, is given to the audience by recognized experts. Will the Quiz retain an equal measure of popularity by reason of its competitive spirit, or because of information given either by the poor unfortunates on the platform, or by the correct answer given of necessity by the judges? Is this the major question, or has the question to be asked: "Is an audience, drawn by the competitive spirit, capable of assimilating knowledge in the short space of time usually devoted to a real quick fire Quiz?" The answer, surely, is contained in the fact that the private discussions afterwards on the marks obtained by the various members of both teams bring out the educational points far more than does the Brains Trust.

As a successful aid to advisory work the Quiz *must* provide a basis for advisory work on the farm; indeed, there have been many instances of this in West Suffolk, but it must be borne in mind that the choice of questions has a great deal to do with this aspect. Every effort must be made to include a proportion of questions whose answers will cover items of up-to-date technical knowledge. At the same time care must be taken to see that there are certain members of both teams who are capable of earning high marks on these questions. In this respect, the method should be adopted of the captain of each team having the right

to nominate a second member of his team to answer a question, if the first member cannot answer it in a stipulated length of time.

The giving of correct and lucid answers to *difficult* questions is one of the best ways of imparting valuable knowledge, and knowledge so imparted has been found, from long experience, to be retained and acted upon to the benefit of both individual and nation.

The questions and answers are so very important, especially the framing of the questions. Furthermore, the judges must be persons of knowledge who are able to give the correct answer with great assurance in order to assist that retention in the memories of the audience which is so important.

In framing the questions care should be taken to provide ample opportunity for well reasoned answers. Often the mistake is made of including too high a proportion of what might be termed catch questions on the one hand and on the other simple questions of fact. Such questions have their value in either providing comedy relief or giving the team reassurance but they should not be overdone. In fact, in drawing up the programme, an attempt should be made to see that the answers to certain questions will bring out definite points it is hoped to " get across " to the audience.

The Quiz must be followed up by the adviser, especially in personal contact with farmers. No Quiz should take place without an adviser present. Further the adviser should assist in the framing of the questions and answers—no easy job. It can be said with safety that, so long as those framing the questions and answers retain their sanity, the Quiz will survive and play a useful part in advisory work.

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